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AND

PATTERN-MAKER.

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ANNOUNCEMENT.

THE PROPRIETORS OF THE "FOUNDRY TRADE JOURNAL" BEG TO ANNOUNCE THAT THE OFFICES OF THE JOURNAL HAVE BEEN

REMOVED TO 165, STRAND, LONDON, W.C.

AN ENTIRELY NEW EDITORIAL AND GENERAL STAFF HAVE BEEN SECURED, AND THE PROPRIETORS TRUST THAT THEY HAVE MADE SUCH ARRANGEMENTS AS WILL ENABLE THEM

TO PRODUCE A HIGH CLASS AND UP-TO-DATE JOURNAL,

WHICH WILL IN ALL RESPECTS MEET THE REQUIREMENTS OF THE FOUNDRY AND PATTERN-MAKING TRADES IN ALL THEIR BRANCHES.

THE STATE OF TRADE.

THERE seems a uniformity of opinion that the outlook for the winter is distinctly better than was the case a month ago. The returns, however, relating to the Trades Unions show that the number of unemployed is gradually creeping up, being as high as 7.9 per cent. unemployed at the end of October as compared with 7.4 per cent. in September, and 5.2 per cent. in October, 1903. The districts in which employment is best seem to be in the South of England, but, unfortunately, these are the less important districts from the point of view of the Foundry Trade. In Falkirk there has been much short time recently. In the Newcastle and Gateshead districts employment has improved.

The figures for the exports of machinery are by no means as satisfactory as they were last month. In October, 1904, as compared with October, 1903, there was a very considerable drop in exports of all classes of machinery. The Scotch Shipbuilding returns show that there was launched during October 27 vessels of 43,495 tons as compared with 22 vessels of 45,819 tons in the corresponding month of last year.

These few figures will enable our readers to pretty accurately gauge the conditions of trade as they are at present. There is a distinctly hopeful feeling, and this is reflected in the Metal Market, which has been rising steadily for some time past. This is a very good sign, the rise in copper and tin having been a very marked one. The rise in pig iron has not been large, but the latest cables from America show that the Pittsburgh market is very active and this, if continued, will soon cause a pronounced stiffening of prices in this country.

THE CRUCIBLE STEEL FOUNDRY OF ARMSTRONG, WHITWORTH & COMPANY, AT MANCHESTER.

THE system of making steel in crucibles is by far the oldest of all others and dates back from time immemorial. What is known as "Wootz" steel was produced in India centuries ago.

It is impossible to say, however, to what actual era of remote antiquity the production of steel dates back, but it is practically certain that carbon steel was used thousands of years ago. It was in Sheffield that crucible steel was first extensively and commercially manufactured by Benjamin Huntsman, during the year 1750, and it is to his skill in so doing that the world is indebted for one of its greatest industries.

Turning now to the present condition of manufacture, it has been proved from long and extensive experience that the finest qualities of crucible steel can only be made by using the best brands of Swedish or Dannemora ores, which, on account of their freedom from impurities—that is, their low percentages of phosphorus and sulphur—render them the most suitable for producing tool steels that will best retain their cutting edges. High percentages of phosphorus in tool steel (anything above .03 per cent. phosphorus would be considered detrimental) is as opposed to good steel as fire is to water. Of course, these Swedish irons are expensive, and the process of converting them into steel is slow and costly, as only comparatively small quantities of steel can be produced compared with the amount of fuel and labour expended. It therefore follows that the best brands of crucible steel must always command a high price.

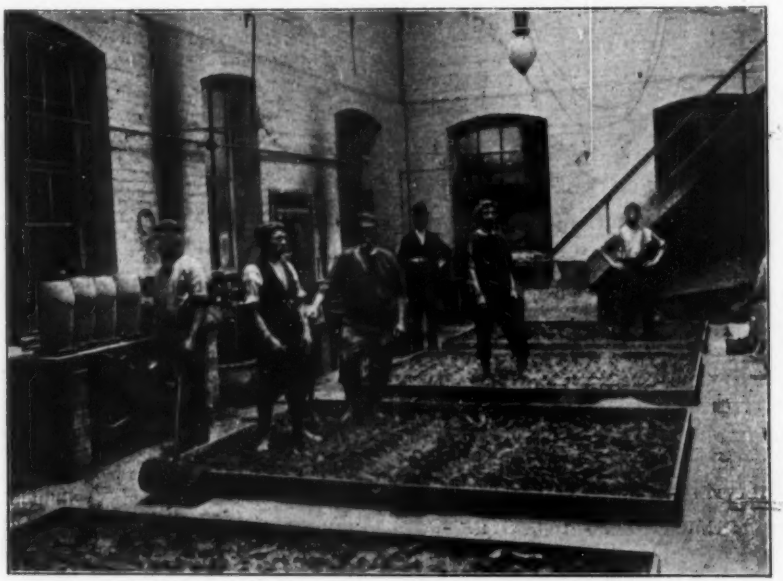

FIG. 1.—TREADING FIRECLAY FOR CRUCIBLES. SIR W. G. ARMSTRONG, WHITWORTH & CO.'S WORKS.

There are several grades or tempers of ordinary crucible steel, each being suited to its own particular class of work.

It is usual to speak of these ordinary tempers or grades by numbers, as for example.

No. 1 *Temper*, containing about 1.30 per cent. carbon, is suitable for small turning and planing tools, drills, and small cutters; also for tools requiring the sharpest edges, *e.g.*, razors and surgical instruments. Great care must be taken not to overheat this quality.

No. 2 *Temper*, containing about 1.15 per cent. carbon, is suitable for turning, plan-

ing, and slotting tools, drills, cutters, reamers, and engraving tools.

No. 3 *Temper*, containing about 0.90 per cent. carbon, is suitable for large circular cutters, reamers, taps and screwing dies, heavy turning tools, large drills, and taps.

No. 4 *Temper*, containing about 0.80 per cent. carbon is suitable for cold chisels, hot setts, small shear blades, and large taps.

No. 5 *Temper* containing about 0.75 per cent. carbon, is suitable for screwing dies, cold setts, hammers, swages, minting dies, miners' drills, smiths' tools, punches, and shear blades.

that users of tool steel should state the purpose for which they require it, for it is obvious from the above grades that using, say, a No. 5 temper where a No. 1 is required, must be unsatisfactory alike to both parties, and often, in consequence, the steel is alleged to be bad, and not unnaturally condemned; whereas, the fact is really that it has been applied to a purpose for which it was not made.

Before describing the process of crucible cast steel, it is perhaps desirable to define briefly some of the substances used in its manufacture, notably, blister steel, which is bar iron that has been heated for a

FIG. 2.—MELTING FURNACE FOR 36 CRUCIBLES. SIR W. G. ARMSTRONG, WHITWORTH & CO.'S WORKS.

No. 6 *Temper*, containing about 0.65 per cent. carbon, is suitable for snaps, dies, cup drifts, hammers, and stamping dies.

Vita Brand is a very superior water-hardening steel specially adapted for finishing brass and steel at increased speeds in turret and capstan lathe work. Also for turning chilled rolls and very hard materials.

Dura Brand is a special water-hardening steel suitable for ordinary drills, twist drills, small mining tools, brass finishing tools, reamer blades, and wood working tools.

It is very important to the producer

long period at a high heat in a converting furnace in contact with carbon; the carbon gradually percolates into the bar, and the bar of iron thus becomes carburised. The surface of the bar, which was previously smooth, becomes rough and dotted with blisters, and the fractured converted bar is quite different from the bar iron, as it has been converted to a greater or less depth into steel. As the change goes on from the outside inwards, the conversion may go to a still greater depth in the bar or even right through it, so that we may obtain cemented bars of different grades steeled on their surface

to varying depths with an iron centre, or bars steeled throughout.

The grades of cemented steels usually made are :—

No. 1	containing	0.5	per cent.	of carbon.
,, 2	,,	0.625	,,	,,
,, 3	,,	0.75	,,	,,
,, 4	,,	1	,,	,,
,, 5	,,	1.25	,,	,,
,, 6	,,	1.5	,,	,,

The process of making shear steel is as follows :—

Five short lengths of blister bar are heated in a hollow coke fire which by the use of a soft blast admits of being regulated to a welding heat. During this time the surface of the bars is covered with clay beaten fine and applied during the heating to exclude the air and prevent oxidation. The bars are then carefully hammered and welded together. This is known as "Single Shear" steel. To make "Single Shear" steel into what is known as "Double Shear" steel, the bar made of "Single Shear" steel, as above described, is broken in the middle, the two pieces laid together, welded a second time and again drawn to the required shape. By this double operation the steel becomes more homogeneous and of a finer texture.

One of the first considerations in the melting of crucible steel is the necessity of ensuring that the crucibles used are of the perfect quality requisite to withstand the very high temperatures required to melt the iron and various alloys, and especially is this the case in the melting of the ingredients of high speed steels, which require extremely high temperatures. As the making of a crucible is an important business, it may be interesting to describe the Crucible Department at the works of Messrs. Sir W. G. Armstrong, Whitworth & Company, Limited, Manchester, as shown in Figs. 1, 2 and 3.

The various fireclays and compounds, carefully weighed, are mixed and trodden with the bare feet and balled, see Fig. 1, so as to thoroughly consolidate the mixture and free it from air spaces necessary to obtain the correct homogeneity required. The compound is then made into crucibles of the desired shapes and sizes, by hand, with the plug and flask. The operation of treading the clay with bare feet may appear to the uninitiated to be a crude one, but mechanical ingenuity has so far failed to provide an equivalent substitute, trodden clay having been found to be more satisfactory in every way than clay treated mechanically.

The crucible is then pressed into shape by hydraulic power. These crucibles are specially for the melting of steel.

Plumbago crucibles made with the "Jolly" are suitable for melting brass, alloys, gun metal, etc. The crucibles are made in all shapes and sizes according to requirement, and hold from 56 lbs. each to 500 lbs.

Plumbago crucibles are finished on the potter's wheel.

Crucibles are always stoved preparatory to being burned or thoroughly dried. To manufacture crucibles, including their formation and drying, occupies anything from three to six weeks, according to size, so that with the high cost of the plumbago and other materials, also the length of time in completion, the item of plumbago crucibles is an expensive one in crucible steel manufacture. The plumbago crucibles made by Messrs. Armstrong Whitworth generally last in the case of steel melting from eight to ten rounds; that is, they can be used eight to ten times before being cast aside, whilst the plumbago crucible for the melting of brass and gun-metal and other analogous alloys will last as many as 36 to 40 rounds.

Proceeding now to the manufacture of crucible cast-steel, it is necessary to first carefully select the blister or cemented bar according to the temper of steel required, and this having been done, the bar is broken up into small pieces suitable for charging into the crucibles. About 56 lbs. of broken bar are generally charged into each, together with the alloys and other necessary substances for the particular temper of steel it is desired to make.

Before the crucible is put into the melting furnace, it has a preparatory annealing in a separate furnace, which is placed close to the melting furnace, so that the crucible is transferred from the former to the latter in a heated condition; this is done to prevent the too sudden heating of the crucible, for were it transferred directly into the melting furnace, it would be liable to fracture. The necessary charges being weighed out are now ready for putting into the crucibles, and are charged therein through a long funnel or bell-mouth tube. The melting holes are either heated by coke or by means of gas in a regenerative furnace, each division of such a gas furnace holding six or more crucibles. The process of melting occupies anything from 3 to 4½ hours, according to the brand of steel being worked—the higher grade brands, such as high-speed steels, taking a longer time to melt and thoroughly mix the various alloys they contain.

The skill of the chemists and leading melters is now brought to bear on the im-

portant operation of melting, and the degree of heat of the furnace is regulated by them, the contents of the crucibles being inspected from time to time, so as to decide the exact time when they are thoroughly mixed together. It is only by long and actual experience in melting that the correct condition can be ascertained as to when the steel is properly melted and is exactly ready for pulling out and casting into ingot form. Before withdrawing the crucible containing the molten steel from the holes, which is done by a man called a "puller out," he takes the precaution to envelop his legs with wrappers saturated with water, so as to prevent his apparel taking fire; but, should he do so, there is every convenience at hand, as a tank is provided close to the pot-holes, into which he can plunge and "extinguish himself."

FIG. 3.—TWO SETS OF COKE-FIRED MELTING FURNACES. SIR W. G. ARMSTRONG, WHITWORTH & CO.'S WORKS.

A pair of double-acting shears are used for cutting up the Swedish bar iron into small pieces for charging into the crucibles. The bars are carefully watched during shearing to see that they are quite uniform and free from defects which would be detrimental to the quality of the steel. Bars of a brand of high-class blister-bar or converted Swedish bar iron are broken by hand, the tempers being selected according to the hardness of the steel required. This blister bar cannot be cut with the shears as the bars are two hard, owing to their being converted into steel. The pieces are now transferred to the metallurgical department, where the various irons, alloys, ferros, etc., etc., are carefully selected and weighed before being charged into the crucibles in the melting furnace.

It may be interesting to give an idea of the cost of some of the alloys used :—

Vanadium	costs 40s. 0d.	per lb.	or	£4,480	per ton.
Molybdenum	„ 6s. 0d.	„	or	£672	„
Tungsten	„ 2s. 6d.	„	or	£280	„
Nickel	„ 1s. 6d.	„	or	£168	„

It will be seen, therefore, that where large percentages of such alloys are used high-class crucible tool steel is naturally a costly production.

A few particulars of some of the alloys may also be of interest.

(1) *Wolfram.*—This is one of the chief ores from which tungsten is made. It is commonly found massive, and associated with tin-stone. The specific gravity varies from 7 to 8, and in composition it is a tungstate of iron and manganese. The analysis gives:—75 per cent. to 76 per cent. tungstic acid; 9 per cent. to 10 per

cent. protoxide of iron; 4 per cent. to 14 per cent. protoxide of manganese.

(2) *Ferro-Vanadium.*—This grade contains 40 per cent. Vanadium and costs 1s. per oz. It is only in recent years that use has been made of Vanadium in the manufacture of steel.

(3) *Ferro-Silicon.*—This is an alloy of iron with silicon varying from 10 per cent. to 50 per cent. Those alloys containing from 10 per cent. to 18 per cent. silicon are made in the blast furnace by the reduction of highly siliceous iron ores, using a very hot blast. The finer grades, those containing from 25 per cent. to 50 per cent., are made in the electric furnace. The higher percentage alloys are spongy and very friable.

(4) *Metallic-Chromium.*—This fracture is very lustrous, and keeps for a long time without tarnishing. This metal is prepared in the electric furnace, and runs about 98 per cent. pure.

(5) *Metallic-Manganese.*—The fracture is very lustrous, but readily tarnishes in the air. Specimens prepared in the electric furnace contain only a trace of carbon and run 98.5 per cent. pure; they are convenient for making steels high in manganese and a low carbon percentage.

(6) *Ferro-Molybdenum.*—Average specimens contain 70 per cent. of molybdenum, and costs 5s. 6d. per lb. One of the chief sources of molybdenum is molybdenite, which is sulphide of molybdenum, and resembles graphite in appearance. Molybdic acid is prepared from mineral, and, after mixing with charcoal, is subjected to a high heat in a covered crucible and reduced to molybdenum powder. This is mixed with iron and charcoal and melted in crucibles to obtain ferro-molybdenum alloy.

(7) *Ferro-Tungsten.* — Some specimens contain 80 per cent. of tungsten. It is prepared by melting together Swedish bar iron, tungsten powder, and charcoal. Other varieties contain from 45 per cent. tungsten, and such alloys are intensely hard and very difficult to break.

(8) *Tungsten Powder.*—This is a metallic powder, varying in colour from grey to black. The specific gravity is very high, viz., 19.4 The wolfram ore is crushed and concentrated and then placed with alkali carbonates whereby the tungstic acid is converted into a tungstate of soda. This is soluble in water, and so can be separated from the insoluble oxides of iron and manganese. Tungstic acid, as a yellow precipitate, is obtained by the judicious addition of mineral acid to the solution of tungstate of soda. The tungstic acid is separated, dried, and, after mixing with powder charcoal, is subjected to a high heat in a covered crucible; the tungstic oxide being reduced to metallic tungsten. Tungsten has the property of imparting intense hardness to steel, especially when associated with chromium and manganese and other alloys. Average specimens contain 98 per cent. tungsten metal. Present price 2s. 6d. per lb.

(9) *Nickel.*—This is another important element used as an alloy with steel, and increases its elastic limit and breaking stress whilst adding toughness and maintaining ductility.

(10) *Ferro-Chrome.*—This is a very rich alloy of iron with chromium, varying from 60 per cent. to 80 per cent. Its price varies from £30 to £120 per ton, according to grade, and these grades are based on the percentage of carbon, the lower percentages of carbon being the purest and most costly. The carbon varies from 1 per cent. to 10 per cent. The higher percentages and finest qualities are now made in the electric furnace. The use of chromium in steel is very general, including armour plates, tool steel, projectiles, etc.

The crucible annealing furnace being relieved of its crucibles, the coke or gas-melting furnace is now charged. Fig. 3 shows a general view of two sets of melting furnaces, the fuel being coke. The shelves on the left and right are stacked ready with crucibles before charging into the furnace. On the left-hand side is a 24-pot furnace being charged with the mixing received from the mixing-room, this being charged into each crucible which has previously been put into the furnace. The men may be seen stripping the moulds from the ingots and "topping" the ingots. By "topping" is meant the breaking off of the ingot-top, so as to reveal the fracture of the steel, by which the expert can tell whether the melting has been good or bad.

A melting furnace holding 36 crucibles (Fig. 2) is also used among others at Openshaw. The furnace is divided into six divisions, and each division holds six pots. Each of the pots holds on an average 56 to 60 lbs., so that in one round of melting about 1,800 lbs. of ingots are produced from such a furnace.

The ingots are carefully looked over in the melting department to see that they are quite sound. The old rule-of-thumb method of judging the different tempers purely by fracture has been replaced by the more scientific way, viz., chemical analysis.

At the tilting-shop, for hammering and finishing, the ingots require to be re-

heated in accordance with their different compositions and then cogged or hammered. The ingots are transferred to a heavy forging hammer and are cogged out to suitable sizes, shapes, and lengths. They are then stacked and allowed to cool, after which a further examination is made to detect any defects before passing on to the smaller hammers for tilting and finishing. The very heavy sectional bars for large milling cutters, shear-blades, etc., are, however, finished under the large hammers.

The cogged bars are finished to the medium sections or square, hexagon, octagon, rectangular, oval, bevel, or other special required shapes. Several hammers are used for this purpose, including one for finishing the smallest sections down to $\frac{5}{16}$ in. square, small rectangular, fine flats and special sections that require very delicate heating and handling.

A three-high rolling mill is also used for cogging and rolling tool steel for ordinary purposes; also for finishing bevels and rounds that are required correct to size. After rolling, the bars are transferred to the reeler.

The reeling machine is for trueing up bars perfectly round and straight, and making them exactly to sizes.

The bars then pass to the annealing process, a very important branch. The very special brands of tool steel must not only be of the highest quality, but must be in such a state that they can be readily machined at the lowest possible cost to the many designs required for milling tools, boring tools, reamers, taps, dies, etc., and tools for delicate and very fine work. Another point of importance is the necessity of eliminating internal strains of brittleness which are set up in hammering, rolling, and finishing.

For the above particulars we are indebted to the various papers read by Mr. J. M. Gledhill, who contributed a most valuable paper at the recent New York meeting of the Iron and Steel Institute, in which he described the results obtained by the use of these high-speed tool steels, whose manufacture has been described in this article.

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THE shipbuilding employers on the North-East Coast have issued notices for a reduction of 5 per cent. on piece rates, 1s. 6d. on wages over 30s. a week, 1s. on wages of 25s. to 30s. a week, and of 6d. on wages under 25s. This affects all classes employed in shipbuilding, and will take effect from November 23.

NOTES ON GRINDING CASTINGS.

WHEELS used for abrasive purposes have two distinguishing characteristics, either or both of which may be varied according to the class of work to be done. These characteristics are the fineness and the hardness of the wheel. Fineness is dependent upon the size of the grains of the abrasive material, and is spoken of as the number or grit. Hardness is the quality of resistance to crumble away, and is spoken of as the letter or grade. Considerable discretion is required in selecting the most suitable wheel for the work to be ground, as a wheel which is too hard heats the work, glazes, and will not cut; while one that is too soft, although it cuts rapidly, wears away very fast. Wheels are graded from soft to hard, the letters of the alphabet being the designation, the commencement representing extremely soft, and so on to the end, which represents exceeding hardness. Wheels are numbered from coarse to fine, according to the number of meshes in a square inch of a sieve through which the grains of abrasive material have passed, the minimum being 6 and the maximum 220. The following table, known as the Norton grade and number list, is of interest for general guidance:—

Table for Selection of Grades.

Class of Work.	No. of Emery or Degree of Coarseness usually furnished.
Large cast-iron and steel castings ...	16 to 20
Small cast-iron and steel castings ...	20 „ 36
Large malleable iron castings	16 „ 20
Small malleable iron castings	20 „ 30
Chilled iron castings...	16 „ 20
Wrought iron	16 „ 30
Brass and bronze castings...	20 „ 30
Rough work in general	16 „ 30
General machine shop use...	30 „ 46
Twist drills (hand grinding)	36 „ 60
Reamers, taps, milling cutters, etc., (hand grinding)	46 „ 100

Emery is found in the form of rock and is crushed into the various grades of fineness. The crushing is done either between rollers or stamps. Much thought and experiment have been directed to discovering a cementing substance to bond the particles of the wheel together to

* Excerpt from the Proceedings of the Institute of Marine Engineers, Stratford, London, E.

meet all the requisite qualifications. The bond has to bind the material together with sufficient strength to withstand the centrifugal force due to the periphery speed at which they are run, and it must neither be softened by heat nor become brittle by cold. It must not be so hard as to project above the surface of the wheel as the abrasive grains break away. It must be capable of being mixed uniformly throughout the grains, so that the wheel may be uniform in strength, texture and density. It must be of a nature that will not spread over the surface of the abrasive, or combine with the cuttings and form a glaze on the wheel. It must, of course, be remembered that the nature of the material operated upon has a great deal to do with the glazing; thus, wrought iron will glaze a wheel more quickly than hardened steel, and brass more quickly than wrought iron; while, on the other hand, soft cast iron has less tendency than either of them to glaze. The principal cements used are hard rubber, chemical charcoal and glue, shellac, silicate of soda and chloride of calcium, celluloid, and ordinary glue. The vitrified emery wheel is bonded with a cement which contacts slightly while cooling, leaving small pores or cells through which water, introduced at the centre, is thrown by the centrifugal force to the surface, thus showing the porosity of the combination. Corundum is a mineral similar to emery, and corundum wheels are made and used in the same manner as emery wheels. Their cutting qualifications are, however, superior to those of the emery wheel, both cutting more freely and being more durable, with less liability to glaze. Corundum was formerly found in plenty but now is scarce. Carborundum, discovered in 1891 by E. G. Acheson, is a manufactured substance which is now being largely used where emery and corundum were formerly. Its components are a mixture of coke, sand and salt, fused by the electric arc. The substance thus produced takes on cooling the form of crystals of great brilliancy and exceeding hardness and sharpness. The derivation of carborundum is carbon and corundum, the abrasive characteristics of each being surpassed by carborundum, which, with the exception of the diamond, is the hardest known substance. The bond used in these wheels is also the vitrified, and the following description, taken from a lecture delivered in 1896 by F. A. Fitzgerald, on the manufacture and development of carborundum manufactured under the Acheson patent which, although peculiarly interesting, would occupy too much time to read *in extenso*, will be instructive. In making wheels or other goods with the vitrified bond, the carborundum is mixed in certain proportions with kaolin and feldspar, and the mixture is then placed in a mould and pressed in a hydraulic press. The wheel, when removed from the mould, is placed on a support called a "bat," which is made of baked clay. The vitrification of the wheels is carried out in kilns similar to those used in making porcelain. The bats on which the wheels rest are placed in clay saggers, and then built up in columns until they reach the roof of the kiln. When the kiln is filled it is closed and fired, an operation occupying about seven days, and is then allowed to cool slowly. When the wheels are removed they have to be placed in lathes trued up with dressers or diamonds, and the hole bushed to the proper size. Carborundum is infusible, insoluble, and of white crystalline appearance. The recommended speed for an abrasive wheel to run is 5,000 ft. per minute, which produces a stress of 75 lbs. per square in. Manufacturers have most stringent systems of tests; each wheel before it leaves their works is run to not less than 9,000 ft. per minute, which gives a stress of 250 lbs. per square in. The following experiments give interesting figures as to the periphery speeds required to burst wheels:—

	No. of Emery.	Working Speed.		Bursting Speed.		Speed Ratio.	Factor of Safety.
		Revs. per Min.	Feet per Min.	Revs. per Min.	Feet per Min.		
1	30	1,250	5,230	3,750	15,700	3.00	9.00
2	30	1,250	5,230	2,750	11,500	2.20	4.84
3	30	1,400	5,870	4,550	19,050	3.25	10.56
4	30	1,400	5,870	5,600	19,200	3.28	10.76
5	36	1,250	5,230	4,100	17,200	3.28	10.76
6	36	1,250	5,230	4,125	17,250	3.30	10.89
7	14	1,200	5,030	3,100	12,970	2.58	6.66
8	24	1,200	5,030	3,800	15,900	3.17	10.00
9	10-12	1,200	5,030	4,100	17,200	3.42	11.70
10	10-12	1,200	5,030	4,350	18,200	3.62	13.10

The table shows the results of the experiments in detail, and needs but little explanation. Wheels numbered 1, 2, 5, and 6, were all made by one firm; the two latter, being of a finer grade, show a correspondingly greater strength. Wheels numbered 3 and 4 contained a layer of brass wire netting embedded in the emery, and were about one-third stronger than the average. The wheels numbered 7 and 8 burst at the average

bursting speed. Wheels numbered 9 and 10 were so-called vulcanised wheels, containing rubber in the bond, and intended for particularly severe service, and showed rather more than the average strength. It is apparent that any of these wheels were safe at the speed recommended and would not have burst under ordinary conditions. It may also be said that such a variation in strength between wheels of the same make and grade as numbers 1 and 2 indicates a lack of uniformity which causes distrust. Considering the violent nature of the service some wheels are subjected to, it would seem that the factor of safety for abrasive wheels should be large.

PATTERN-MAKER'S CORE-BOX PLANE.

A "Foreman Pattern-maker" writes:—I am a constant subscriber of your valuable journal, and was pleased to see the article in your October number dealing with the Right Angle and Tool Core-Box Plane. But I wish to remind you that the plane is not the best for its purpose, as it has too many disadvantages to recommend its use to the average pattern-maker. Among these disadvantages are the following:—

1. It occupies too much time getting the wood roughed out to within quarter of an inch of the line.
2. It rounds off the corners of the core-box by friction.
3. It will only work on a small semi-circular box, and is not applicable to large sizes or for work other than a complete half circle.
4. Is a very difficult tool to use, and depends too much on the edges of the box being sound and truly parallel.

The remarks in your journal on core-boxes by a recent writer as regards the use of calipers are no doubt true concerning misfit cores, but only a boy learning, and inexperienced, or possibly a joiner in a jobbing foundry, would use a crooked two-foot rule.

As regards cores expanding, I have often made large loam cores to common rule, on the foremen moulders' advice, as they allow for their cores expanding. This is especially true in the case of large wheel boxes and the like.

MR. A. WISEMAN, the proprietor of the Electric Tramway Equipment Company, has extended his works in Glover Street, Birmingham, and is now engaged in gear cutting in a great variety of sizes.

THE "CIRE-PERDUE" PROCESS OF BRONZE CASTING.

IN the casting of architectural and art bronzes we are generally, and with some truth, believed to be behind our fellow craftsmen on the Continent. It has only been within a few years that we have been able to approach the French, Italian, and Russian bronze work, and this success is entirely due to the introduction of the "cire-perdue" process of making bronze castings. This process has, of course, been in use for hundreds of years, but the scientific American has obtained details only recently.

While a similar though much cruder

FIG. 1.—MAKING FULL-SIZE CLAY ORIGINAL, WORKING FROM SMALL CLAY OR WAX MODEL.

method was in use by the ancient Greeks and Romans, it was developed to essentially its present state by the great Florentine goldsmith and bronze worker, Benvenuto Cellini, about the middle of the sixteenth century, and has remained practically unchanged to the present day.

The "cire-perdue" process differs radically from the common or sand casting in several ways, and the latter can in no wise compare with it. Its principal advantage is that no matter how complicated or involved the original may be, the bronze reproduction can be cast in a single piece. This does away with assembling the separately cast bronze pieces, with the

consequent inevitable traces of the joining. Further, there is no tamping of sand in the mould, with the danger of destroying detail, and finally, a complete casting takes about half as long to make by this method as by the other.

Though the sculptor usually carries out his conception in clay or wax of the same size as the intended bronze, it is sometimes inconvenient, especially if the statue is to be of heroic size, to do this, and consequently the artist's original is frequently much smaller in size. As, however, full-size plaster casts are necessary in this or any other process of bronze casting, a full-size clay model must be constructed from the small original. The illustrations show the manner in which the whole or the parts of a model are enlarged.

FIG. 2.—RETOUCHING PLASTER MODEL.

When the original or plaster replica is received from the artist, the first step in the "cire-perdue" process is to make a plaster or gelatine mould or "negative." Within this negative a hollow wax figure or positive is now built up, the wax being applied with a brush till it is of the thickness that the finished bronze is to be. This part of the process, as is easily seen, is analogous to sand moulding, and the wax figure must be made in separate pieces whose size and number are determined by their shape; for instance, if a half-closed hand is to be moulded, the fingers and the body of the hand would have to be separately reproduced and afterwards assembled, as otherwise it would be manifestly impossible to remove the pattern in one piece without destroying the mould. The analogy ceases with the assembling of the separate wax pieces. The complete figure is retouched as much as necessary, and, as the medium is wax,

FIG. 3.—PUTTING ON CHANNELS, GATES AND CORES.

by using heat in the assembling the joints can be absolutely done away with, so that we have an exact wax likeness of the artist's original. A great advantage of

FIG. 4.—SAND MOULDING.

this method is that, if he desires to do so, the artist can change or retouch the wax figure as much as he pleases. The wax is sufficiently hard to permit handling, and will take the most delicate impression.

The next step is the making of the final mould for the metal. This is made of a composition, liquid in form, that hardens in a few minutes after its appli-tion. This composition is poured around the wax figure and, as can be easily understood, makes as exact a mould as can be produced, and, moreover, entirely without ramming or tamping. At the same time an outer shell of a coarser composition is built up around the mould to give it greater strength. An opening or two is left in the hollow wax figure so that the composition may be poured into it to form the inside core. Bronze rods are driven through the wax at several places, projecting on the inside as well as the outside, in order to hold the outer and inner cores in their proper relative positions on removing the wax. Before the completion of the outer core, wax rods or bars, that later form channels for the metal or vents, are attached to the wax figure wherever necessary, all leading to one main channel in the upper end of the mould. The enveloping of the figure with the composition is now completed, and the mould placed in an oven and baked over a slow fire. Under this treatment the wax runs out, leaving a mould of the complete figure, while at the same time the composition hardens. The mould is now ready for running the molten metal.

The casts come from the mould in an almost perfect condition, the minutest detail being as clear and distinct as if chiseled by hand. Beyond removing the channels and vents, which, of course, have been filled with metal, and brushing off the particles of the hardened composition with a stiff brush, the figure requires no attention other than the usual final colouring or patining, which is done with acids and chemicals.

In the "cire-perdue," freely translated "lost wax," process as used by the Greeks and Romans, an inner core was made roughly of the desired shape and covered with a layer of wax. In this wax the artist modelled the figure, and then the outer core was put on surrounding it. The mould was then baked, the wax melting out, and the metal run in. While this made an exceedingly good bronze of the artist's conception, it did not permit of making more than one, and was consequently impracticable for modern use, till the genius of Cellini developed the process to its present state.

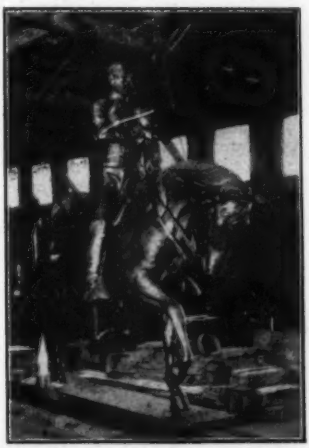

FIG. 5.—COMPLETELY ASSEMBLED WAX POSITIVE OR PATTERN.

FIG. 6.—FINISHED BRONZE.

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BELL BROTHERS, LIMITED, Middlesbrough, are putting down a large electric plant for supplying their own works, and also the Clarence Steel Works of Dorman, Long & Company, Limited.

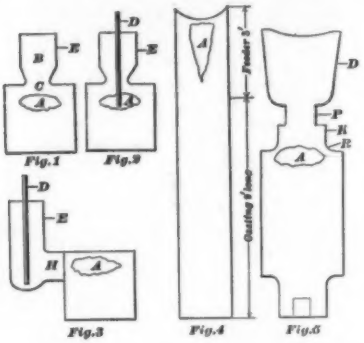
RICHARDSONS, WESTGARTH & COMPANY, LIMITED, have had such a demand on their turbine department that their iron foundry has been enlarged, and they are also building a new brass foundry to cope with the increasing requirements of their three works.

SHRINKAGE TROUBLES AND METHODS OF "FEEDING."*

By Thos. D. West.

A casting that is not sound is weakened in a way that makes it impracticable to apply any formula to ascertain its strength. The extent to which such unsoundness affects the life of the casting depends chiefly upon the location of the defects. In some cases unsoundness may not be of great importance, while in others it may be so serious as to unfit the casting for use; but discrimination in this respect must be left to experience and judgment.

Unsoundness in castings is produced by one of three things: A "blow hole," "dirt hole," or shrinkage. Rarely, if ever, are two of these factors combined. The unsound spot must be produced distinctly by either gas, dirt, or shrinkage. However, it is possible for dirt to lodge in a section that would also shrink. I dwell on this feature because I believe it will assist in forming correct opinions as to the cause of any unsoundness to be found in castings.



Shrinkage as Distinct from Dirt or Blow Holes.

A few days ago I received a defective section of a valve casting, and was asked to indicate the cause of the defect. This special valve casting had to stand several hundred pounds of hydraulic pressure test, which, when applied, caused a leakage at the pouring gate section. The parties sending this sample were at a loss to know whether the porous condition was due to shrinkage or dirt. They seemed sufficiently experienced to know it must be one or the other. The first thing I did was to apply a magnifying glass. This enabled me to be very emphatic in attributing the trouble wholly to shrinkage, and I wrote them that if they would change their pouring gate to a lighter section, I believed their trouble would cease.

Examination by the glass showed the section that leaked to be of an open, stringy structure, reminding one of a lot of peas tied together with very fine thread. The open spaces were entirely free of any dirt, whereas the solid section of the casting was of a close uniform density. There was not the least sign of dirt being confined between the spaces, or open grains of the iron. Some might refer the trouble to confined gases causing "blow holes." These do not exist as open-grained, stringy structure as in some forms of shrinkage. Any sponginess or holes due to confined gases appears in cavities surrounded with a structure denser than that adjoining the defects; and the surface of blow holes often appears as smooth and dense as the interior of a piece of blown glass. In fact, the formation of holes by expansion of air or gas are upon the same principle. Molten iron or glass is easily separated by air or gas pressure, forming a void space before solidification, and molten iron will liberate gases up to a certhin decrease in its temperature, just as air can escape from water before it freezes. Let one fasten the above facts in his mind, and there should be no difficulty in determining whether a defect is caused by dirt, confined gases, or shrinkage.

Symbols for Methods of Treating Shrinkage.

There are several different methods of preventing shrinkage evils in castings. At present we have no terms or symbols to designate one method from another, and it appears to me that to have symbols that can be universally applied would prove of service to all interested. The terms I offer to cover the present different forms of general feeding are:—(1) Interior rod feeding; (2) exterior rod feeding; (3) statical pressure feeding; (4) chill feeding; (5) compression feeding. The first and second terms may be used in some cases with the word rod omitted. The question of symbols is taken up at the close of this paper.

It is surprising how few moulders and founders comprehend the difficulty of making a bulky casting perfectly solid throughout its body, and it is said to be that while skill in placing proper feeding heads and in feeding can accomplish much

* Paper read before the New England Foundryen's Association.

in avoiding the evils of shrinkage, there are forms that baffle the most skilled attempts to make perfectly solid castings.

Difficulties in Feeding and Rate of Cooling.

The great difficulty in obtaining a perfectly solid body in many forms of bulky castings is due to the exterior part solidifying before the interior, and the impracticability oftentimes of conveying to the part solidifying last the hot metal that will fill the void space left and replenish the shrinkage. In the solidification of a casting the radiation of heat is greatest upward. The bottom and sides will solidify to a greater depth than the uppermost or top body before the whole has become solidified. As an example, a cube casting, as in Fig. 1, would have the part last to solidify at about the height seen at A. If the one feeding such a casting can maintain open communication between the hottest part A and that of the feeding head at B until A has solidified, he can produce a solid casting; otherwise he will fail. What works against reaching A with occasional supplies of hot metal in such castings is the early cooling off of the top body at C. It is difficult to keep it in a liquid state to the same length of time that the metal is liquid in the more central section at A. This is generally accomplished by the use of what is termed a "feeding rod," seen at D, Fig. 2. This is kept in motion up and down as well as sidewise. Its action keeps mixing the metal in the feeding head E with that in the interior of the casting. This interior "rod feeding" applies to all forms of feeding where feeding heads are placed directly upon the top or cope surface of a casting.

Interior Rod Feeding.

"Interior rod feeding" secures a perfectly solid casting providing the person working the feeding rod D can keep a liquid communication between a feeding head and the interior of the casting, or that part last to solidify. To do this, as all experienced moulders know, requires the greatest care and skill, and it is to be said that without these more harm than good can be done. The great difficulty with this method of feeding is in keeping the passage for fresh supplies of hot metal open until the hot spot A has solidified. The cost of chipping off large feeding heads and the great danger of cracking some castings in doing so, cause most persons to use smaller feeding heads, as a rule, than should be employed. Were it possible to have feeding heads for cannons, plain shafts, etc., seen at Fig. 4, there woud be litte difficulty in obtaining a solid interior in bulky castings.

Exterior Rod Feeding.

In taking up the exterior rod feeding, which covers all that class of work having the feeding head E set to one side of the casting, and a connection cut between the two as at H, Fig. 3, a feeding rod D is generally used, the same as in Fig. 2. The main difference between the Fig. 2 and Fig. 3 plans lies in the latter never permitting the feeding rod to penetrate

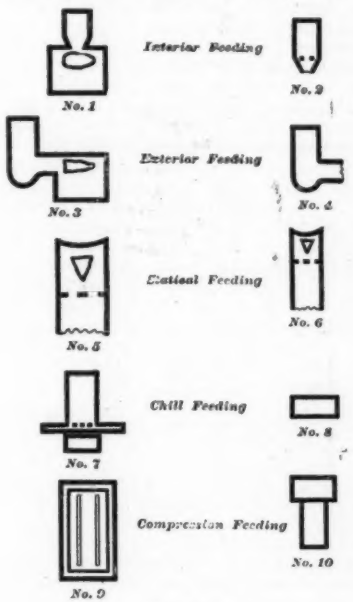


FIG. 6.

the casting or its "hot spot." This militates greatly against obtaining a perfect solid casting unless the feeding head E and connection H are as bulky as the casting, and even then the earlier solidification of the sides ahead of the upper centre body of the casting will prevent the connection H from conveying metal to the hot spot A. However, it is to be said that exterior rod feeding, in the hands of the majority of moulders, can be generally relied upon to give a more solid casting than the interior rod feeding of Fig. 3; at least, there will be more of the external appearance of soundness in rough castings by the plan of Fig. 3 than by that of Fig. 2, whatever may be the internal conditions of the "hot spot."

Statical Pressure Feeding.

This third form includes all that class of feeding involved in the casting of cannon, shafts, rolls, etc., cast on end, where the feeding head is often made the same area as the casting or larger, extending it so that the whole may often appear like one casting without a feeding head, when taken from the mould. The principle involved is seen in Fig. 4. Here the shaft-casting wanted is ○ ft. long, having a feeding head of 3 ft. long to make the casting solid. At A is seen the hot spot, or the body from which the metal descends to supply the shrinkage of all below it. In depending upon self-feeding, long feeding heads are necessary, and it is generally advisable to feed with a rod a few moments after adding fresh supplies of hot metal in the head, and this should be kept well covered with blacking dust, etc., to prevent the escape of heat as far as possible after every addition of new metal, and a few rod feedings.

In the case of rolls that have the neck K smaller than the body, in connection with wabblers P, it is very necessary, if employing feeding rods, to use one after every fresh supply of hot metal, in order to feed up the hot spot A; and at the latter end of the feeding the rod must be constantly used with the greatest skill, otherwise shrink holes or sponginess will be found in the neck at R when finishing the rolls. Especially is this true of rolls having large bodies and small necks. Wabblers in roll moulds are so effective in closing up the connection between the body K and head D, to prevent new metal reaching the hot spot A, that some roll founders have left them out to be machined to form after cutting off the feeding head. Where the wabblers are omitted some depend almost entirely on self-feeding of the head, by covering it well with blacking dust after every fresh supply of hot metal. In fact, this is often much safer than depending on the majority of moulders to make rolls solid by working a feeding rod.

The secret of making solid rolls is to keep on reaching the hot spot with fresh supplies of hot metal until it has solidified, and he that can best do this will be least likely to find shrink hole or sponginess at R when finishing the rolls, or the neck breaking off when they are in use. Many moulders think that as long as they can keep the top and neck body of their feeding heads in a good liquid state they are doing all that is necessary; nevertheless, these remarks on the advisability of reaching the hot spot with all the hot metal possible, as well as keeping the top of the feeding head good and hot, should cause some to do a little deeper thinking.

Chill Feeding.

This method is one which seeks to prevent the formation of a hot spot, and consists in forming of iron any section or part of a mould for a casting that gives trouble from shrinkage, forming in sand all other parts of the casting. The chill or "chiller," as more recently termed, causes the part or parts that would be among the last to solidify, if formed of sand, to solidify in closer unison with the lighter parts that would draw metal from it, to supply their shrinkage. This is of late origin, and many use the method to good advantage.

Compression Feeding.

This embodies complex proportions in thickness of castings and forms of cores, or core irons, as well as any compression methods that may be used. The expansion of the cores by reason of the rods in them may be so great as to compress or drive the metal from heavy parts to supply the shrinkage of light, so as to decrease the body in which the "hot spot" would be created were there not a pressure to compress such heavy parts into less space. This expansion of cores or rods has been known to drive metal back out of risers, and cause castings to come larger than the pattern from which they were made.

Symbols of Feeding Methods.

With the proper advance in founding it would be of advantage to have signs as well as words to designate feeding methods. In making out orders for casting, steel or rubber stamps could be used to mark on orders, or chalk to mark on patterns, any methods designated in Nos. 1 to 10, Fig. 6. The foreman would thus have better assurance of moulders following his desires in the choice of methods. If the foreman takes no interest in the matter, but leaves it with the moulder to do as he pleases, as many do, the knowledge that order blanks have provision for shrinkage symbols should cause him to recognise it as something he should study more and have better control of. The size of feeders and their position can be marked on the pattern, and if cross bars, etc., will not permit their attachment at the place designated, then the moulder will feel called upon to consult the foreman, instead of going ahead regardless of results, as too many do.

Drawings may also be marked in some

cases with a symbol of the best method to insure sufficient solidity of the casting. If the existence of terms and symbols to designate different methods of feeding did no other good than to cause designers and draughtsmen to study the subject of shrinkage, and thus make designs that would aid in securing solid castings, a good work would be done.

It is intended that the symbols opposite each other, as No. 1 and No. 2, will indicate the same method of feeding. The only differences are that one form is simpler and takes less space than the other, and that the larger symbol shows the hot spot, which might in some cases attract more attention to the necessity of good long feeding.

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ENGLISH-MADE PATTERNS GO TO AMERICA.

An interesting fact recently was brought to light, which shows the cheapness and quality of English patterns as compared with those made in the United States. The facts are that until a year ago, R. Hoe & Company employed about 40 pattern-makers at their factory in New York. About that time labour troubles developed here and the firm began to send blue prints of its patterns to its English factory, and to have the patterns made there from the blue prints and imported. At first they were admitted free of duty under the clause permitting free entry to "models of inventions and patterns for machinery." The Union, finding that the force of pattern-makers in New York had been-reduced from 40 to 10, set about finding out the reason, and as soon as discovered complained to the Treasury Department, with the result that an order was issued to classify the patterns as manufactures of wood at 35 per cent. duty. Messrs. Hoe & Company, appealed, and at the hearing, the importers argued that the language of the law admitting "patterns for machinery," free of duty was so clear that it was capable of only one construction. The Government argued that, taken in conjunction with the words "models of invention," it was evident that the intention of Congress was only to permit the free entry of patterns embodying some new idea and that the commercial importation of ironmoulders patterns was never contemplated. The Board reserved its decision.

FOUNDRY PRACTICE WITH COPPER AND ITS ALLOYS.

Copper and its alloys are very important materials from the standpoint of the electrical engineer, and since a large part of these materials must be shaped by casting, the foundry practice in connection with them becomes important. The process of casting is apparently simple: Copper is not hard to melt, and when melted it is not difficult to pour the fluid mass into a properly shaped receptacle. Sad experience has, however, shown the foundryman that good results cannot be obtained by any haphazard methods.

The first requirement is that the copper must be heated to exactly the right temperature. If the heating be prolonged and the metal is brought to a bright red heat, it becomes "soaked," as it is called. After being poured there is a period of quietness, and all seems well; suddenly there is a small explosion; the sand is blown from the flask, and the metal at the gate flies in all directions. When the casting is examined it is usually found to bear no resemblance to the pattern. If the heating be incomplete and the temperature too low, the action will be somewhat different, but the result will be no more satisfactory. There will be no explosion, but, instead, the sand on the copper rises and breaks up; the metal at the gate swells, and the liquid copper continues to ooze out for some time. When examined the casting is found to be full of blow-holes, their number depending upon the temperature at which the metal was cast. The effect of overheating or underheating is the same, regardless of the fuel employed—whether coal, coke, oil, or gas.

The second requirement is that the sand shall have a proper temper, neither too wet nor too dry; experience alone can teach one how to best fill this requirement. If copper is poured into green sand, the casting will be full of blow-holes. On the other hand, dry sand will not hold together. The foundryman's hardest problem is to produce castings free from blow-holes. Sometimes a casting will look all right on the outside, but blow-holes are found inside when the piece is turned up. Every job requires instructions from the foreman about the temper of the sand, position of the gates and risers.

At the Westinghouse foundry castings

* Paper read before the Electric Club by Mr. J. Reardon.

are now being made without difficulty which range in size from 1 oz. to 500 lbs. The difficulties have been overcome by observing the following rules: (1) Heat to exactly the right temperature; (2) have the sand at the proper temper; (3) melt the copper quickly; (4) keep the metal covered at all times; (5) never let the metal stand in the furnace when ready; (6) add a small amount of silicon copper.

In mixing and melting brass a few simple rules should be observed: (1) Weigh carefully; (2) melt quickly and uniformly; (3) prevent volatilisation as far as possible; (4) pour at exactly the right heat. The first rule may seem needless, but bad results are often traceable to careless weighing. Pouring at the proper temperature is of the utmost importance. At the present time the temper is estimated by the naked eye, the experience of the melter and skimmer being relied upon to decide when the metal has reached the temperature proper for the alloy and the character of the job to be done. The use of the pyrometer in the Westinghouse foundry for the determination of temperature has not been attended with great success, chiefly on account of vibration. In other places the instrument has proven unsatisfactory because of its sluggishness in responding to changes of temperature.

A bearing metal resembling glyco-metal has been used in the Westinghouse foundry which gives excellent results. It is composed of copper, tin, lead, and zinc. This alloy is difficult to make because of the tendency of the lead, whose specific gravity is high, to settle to the bottom. There seems to be no amalgamation of the lead with the proportions of copper and tin used. To check the precipitation of lead the bottom of the casting was chilled with running water immediately after pouring. This gave good results in small bearings, but did not with large. Finally methods of mechanical mixing were adopted which gave excellent results both in casting and on test.

Another alloy was made up of the same elements, but a different scheme of mixing was adopted. The mixing was divided into two steps, the first consisting in making an alloy low in copper, and the second mixing this intermediate alloy with copper. The intermediate alloy was made by melting the copper first under a charcoal cover and then adding lead, then zinc, then tin, overheating being carefully avoided. This intermediate alloy was poured into ingot moulds. After cooling it was put into melted copper. The resulting alloy could be cast in sand and withdrawn while red hot without showing any signs of lead sweating out, although the temperature of the casting when withdrawn was far above the melting point of lead. The temperature must be watched very carefully, as a slight excess causes the lead to segregate, and, chiefly for this reason, the alloy cannot be made in a Swartz furnace.

In the melting of alloys it is customary to melt first the constituents having the highest melting point and then to add the others in the order of their melting points, the one with the lowest melting point being added last. Sometimes, however, metals will alloy at a temperature below that of the melting point of some of the constituents. For instance, a brass may be made by first melting zinc, which melts at about 800 degrees Fah., then taking the crucible out of the fire and adding solid copper whose melting point is about 2,000 degrees Fah.

A singular point about alloys containing lead and tin is that lead will separate out if the percentage of tin is considerably in excess of that of lead, but by decreasing the percentage of tin and increasing that of lead the larger proportion of lead alloys without difficulty. There is an alloy known to the trade as plastic bronze, which contains 20 per cent. of lead. This large amount of lead is probably held by a small amount of tin and nickel. The alloy gives excellent results.

In the Westinghouse foundry the moulding machines are arranged in two rows, one on each side of the middle aisle. The conveyors, one over each row, carry the sand from spouts which discharge into the flask. The operator, by opening a gate in the spout, allows sand to pour into and fill the flask. When ready for pouring the flasks are set in line along the grating, and as soon as the metal has been poured and is cool enough the flasks are dumped on this grating, through which the sand passes to an automatic riddle. The riddle catches and throws out all scrap, nails, etc., and the sifted sand is carried by belt conveyor to a set of rolls. After passing through the rolls it falls into a self-dumping pan, where a certain amount of water is added, bringing it to the right temper. An elevator takes the sand as it is dumped from the pan and carries it to the overhead conveyor to be used over again.

The sand gave no trouble when the distance handled was 50 ft. or less, but after a longer haul it was left in such condition that it would not hold together when the hot metal struck it, but washed away like so much powder, losing entirely the shape

of the pattern. When examined under the microscope this sand was found to be entirely disintegrated; the grit and the loam were separated, and formed into globules that would not stick to each other. The difficulty was overcome by passing the sand, after being discharged from the flask and riddled, between a set of chilled rolls. These rolls have to be kept in good shape, for as soon as they become worn, the sand returns to the disintegrated condition.

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SMALL PLANTS FOR THE PRODUCTION OF STEEL CASTINGS. — AN ELECTRICAL PROCESS SUGGESTED.

By R. M. Daelen.

The production of castings in small quantities has occupied the attention of experts during the last twenty years, because crucible melting is too costly for many purposes, such as steel castings, unless a special quality is required, and because a process is wanted which adapts itself to manufacture in small quantities.

In this respect small Bessemer plants seemed best suited to all conditions, and the author has followed their developments for 15 years with great attention. So far as this process belongs to modern times—it must be remembered that Sir Henry Bessemer commenced with small converters, and even to-day such converters are at work in Sweden—the late Mons. Ch. Walrand, of Paris, was the pioneer, for he designed and worked the Walrand-Delatte converter towards the end of the eighties, and from this, later on, arose the Robert and also the Tropenas converter. Since then several other variations of the system have been brought out and introduced into practice with varying success. The main feature of the system consists in introducing the air from the side and blowing it on the surface of the bath, as is also done with the so-called Swedish converter, but which has been abandoned for many years with big plants in favour of blowing through the bottom of the converter. There is no really convincing argument for giving preference to blowing small Bessemer converters from the side. On the contrary, it is more difficult to produce the necessary heat in the bath, as the combustion of carbon and silicon proceeds more slowly than with blowing from below, and, therefore, in the former case, the pig-iron must contain 3 to 4 per cent. of silicon, as against 2 to 2½ per cent. with the latter, the waste being consequently lower. Also it is impossible to apply the method of blowing from the side to converters of less than 1½ tons capacity, whereas with blowing through the bottom, converters of from 6 cwts. upwards may be used.

In small Bessemer plants in the proper sense only those of Walrand's system should be included, as these work converters of from 6 cwts. to a ton, whilst those blown from the side require capacities of 1½ to 2 tons, which, with six blows per shift, brings the daily output to between 6 and 10 tons, which is too much for the conditions of most small plants.

So-called "small Bessemer" plants have the advantage, it is true, of easily adapting themselves to small quantities and varying qualities, but according to the latest experience, they can no longer be considered as being economical in their initial as well as in the working costs. The former are high owing to the high blowing power required, which is about 4 h.p. per 100 lbs. of material charged for both blowing the air from the side and from below. With a smaller blowing power, as is required for blowing from the side, the time of blowing is longer and the consumption of steam therefore equally high. A basic lining not being suited for small converters, a hematite pig-iron high in silicon must be used, which requires a special cupola with a high consumption of coke. Indeed, a complete separation of the iron foundry from the steel foundry becomes necessary, so that there is no advantage to be derived from the existence of an iron foundry.

Assuming that the hematite pig-iron costs between 70s. to 80s. per ton delivered, and adding to this about 50s. to 70s. working costs, brings the price of molten metal up to 120s. to 150s., which must be considered as very high, though perhaps the selling price of small castings may permit such a cost if the moulding and casting is managed to such perfection that there is no high percentage of defectives.

In this respect, however, the small Bessemer process compares rather unfavourably with the other known melting methods, being to a greater extent dependent on the experience and ability of the engineer or foreman in charge.

An engineer building a plant may say to himself that he will supply a perfect small Bessemer plant and hand it over to the customer after having put it to work, and having produced the daily out-

put as previously settled in quantity and quality, but he cannot guarantee that this state will be lasting, as he has no control in selecting the manager. Wherever the daily output permits it, a both theoretically and practically trained engineer should be put in charge, who not only knows how to make the steel, but also possesses a thorough knowledge of moulding and the further treatment of the finished castings. Unfortunately, experts of this kind are rarely at disposal for new plants, and yet the whole success depends on them. Where the plant is too small to pay for an engineer, the responsibility must be almost entirely left with the foreman, and it is perhaps even more difficult to find a suitable foreman than an engineer. Every expert who knows the working of small Bessemer plants will thoroughly agree with these statements. A further difficulty is the treatment of the liquid metal. It is a well-known fact that the quality of steel castings, especially as to density, greatly depends on the temperature of the metal when poured into the moulds. In the converter it is very difficult to gauge the temperature, yet the pouring of the metal must be commenced at a certain moment. A great deal of experience is wanted to gauge this temperature by eyesight alone with certainty, and if mistakes were not made in this and other ways, and the figures for defectives were not often high, all steel foundries ought to do splendidly, which, unfortunately, is not at all the case. The difference between the price of the liquid metal and that of the finished casting is extremely high under all circumstances, even with small Bessemer plants. Liquid metal costs, say, £7 10s. per ton; steel castings £15 to £40. The costs of moulding, annealing, and dressing vary, but they are not so high that a considerable net profit would not be left if the figures for defectives were lower. This, however, almost entirely depends on the experience and ability of the superintendent.

A welcome substitute seemed possible in the small open-hearth furnace on the Siemens' regenerative system, which is free from some of the above disadvantages. This furnace was first built by the inventor Martin, of Sireuil, France, some 45 years ago for a capacity of 2 tons, but it was soon found out that it only worked economically when built to greater capacity. It was only after a long series of years, after a great deal of experience had been gathered with the larger furnaces, that smaller furnaces were again built for steel castings. But even then the lower limit was 2 tons, and larger furnaces, such as 5 tons, were given preference. The open-hearth furnace, however, only showing economical results when continuously worked, the output was frequently too large, and it was often necessary to have recourse to making ingots, in the sale of which, however, there is the competition of big makers, whose costs are about 50 per cent. lower. This, consequently, resulted in loss. The main reason for the well-known fact that steel foundries—whether fitted with small or large melting furnaces—do not work satisfactorily, is not only the present scarcity of orders and the low selling price, but above all the absence of proper melting furnaces which can be sufficiently adapted to the varying requirements of the work.

In France and Sweden there are already a number of electrically heated melting furnaces working successfully for different purposes. The cost of production of the liquid metal is not too high for steel castings. These furnaces are built for a capacity of 3 tons, and some of them are made of the tilting type, after the style of the Wellman open-hearth furnace, the electric current heating the metal bath from the surface. This system seems unfavourable for small plants in two directions, as both the quantity of metal with each heat and the total production with continuous work become too great. In order to avoid these difficulties, furnaces of the crucible type should be built with a capacity of from 2 cwts. to 1 ton, and they should be made tilting like a Bessemer converter, and the heat supply must be conducted through the walls of the crucible.

For this purpose the electric arc cannot be applied, but the heat must be produced by electrodes being inserted in the refractory lining. This system has for some time past left the experimental stage, and several plants are at work with success. A suitable shape for the electrodes in actual practice is that of a fine-grained composition being filled into the intervals which are left in the refractory walls and which may be refilled after wearing out. This system is built by the Kryptol Gesellschaft, Berlin, and judging from the results hitherto attained, the field is likely to rapidly expand.

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GEO. G. BLACKWELL, SONS & COMPANY, LIMITED, of the Albany, Liverpool, have issued an interesting little booklet concerning the fluorspar mines operated by the firm. We understand that they are the largest group of the kind in the world, and at present the firm supply at the rate of some 30,000 tons yearly.

MAKING A WORM WHEEL PATTERN.

THE making of worm wheel patterns has always been somewhat of a difficulty to me, but some time back I was obliged to make one, and I decided on the plan that I shall describe:—The wheel in question was 19-in. pitch diameter and had 48 teeth, concave face to conform to the worm which was about 5 in. pitch diameter. I will confine myself to the wheel, the construction of which I think may be new to some of your readers, as it is to me. The results obtained were highly satisfactory, in fact, I have seldom seen a cast gear that would stand as critical an examination as this For although such inaccuracy would be intolerable in a cut gear, my experience has been that most cast gears are fully as bad

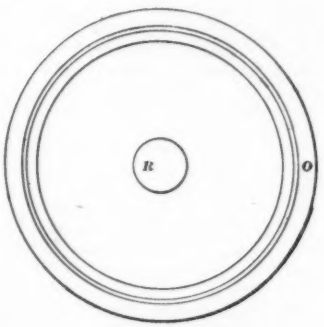


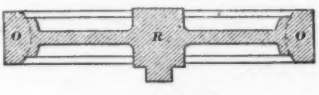
FIG. 1.

if not worse than this. I set my calipers to the outside of the first and third tooth, and had a gauge so that the calipers always touched the same circle. I found no variations exceeding .02 in. and the diameter varied less than $\frac{3}{64}$ in. I have seen patterns that had greater errors. The form of tooth was the involute, and I will say here that I believe that form for most purposes is the best.

This pattern, instead of having the teeth in the pattern, had a core print the same as is sometimes used in making sheaves, and the teeth were made in dry sand. Fig. 1 is an elevation of the pattern and Fig. 2 a cross section, R being the body of the wheel and O the core print for the teeth. Fig. 3 shows a longitudinal cross section of the core box. Fig. 4 vertical section. The box is open top and bottom and is one-sixth of a circle, the side L being doweled onto side M at *a a*.

The central tooth G, Fig. 3, is fastened permanently onto the part M, likewise the half teeth I and H. The three teeth C, C, C are fastened onto the part E, the teeth D, D, D onto the part F, these parts being nicely fitted and perfectly loose, *i.e.*, free to push out but no play. A $\frac{3}{4}$ in. hole is bored in M at *b* and b^1, and a large wood screw screwed into parts E and F. These may not be needed, but better be put in. Now, in the making of the core, the box is laid on the core plate and a core rammed up; then the box is turned up on the bench with the side M uppermost and this part lifted off, the parts E and F remaining in the sand, but should they stick a little rap lightly on the screw heads *b* and b^1. After these have been drawn out, the core may be laid on its side on the core plate and is ready for the

FIG. 2.



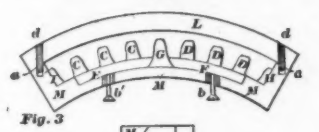


Fig. 3

FIG. 4.

oven. The advantage I see in this method is that the pattern is more easily made and is vastly more durable when done. The moulding is extremely simple, requiring probably less than an hour, including the core making. Besides all that, if you want to change the pitch, or change from right to left-hand, or make straight face instead of concave, you only have the core box to make.

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THE WHESSOE FOUNDRY COMPANY, of Darlington, have recently completed a very comprehensive scheme of extensions to their establishments. Some new large erecting shops, each 300 ft. in length, have been erected. The Whessoe Foundry Company are now completing an important order for no fewer than 8,000 tons of segments for the extensions on the Baker Street and Waterloo Railway.

CARBORUNDUM FIRESAND.

THE question of refractory material is of special importance in all metallurgical operations. The frequent renewals in structures required to withstand intense heat often constitutes by far the largest item in the cost of operation. The proper selection of refractory material and improvements in manufacture are now receiving more scientific attention than ever before, but progress can not be said to be rapid.

The perfect refractory material should resist (*a*) the most intense heat without fusion; (*b*) it should resist all furnace atmospheres, whether reducing or oxidising; (*c*) when in contact with the charge, it should withstand the action of fused substances and scouring slags; (*d*) it should have mechanical strength, and should not expand or contract unduly in heating or cooling. It should, in fact, be chemically inert and passive in the presence of all substances at all temperatures. As such a substance does not exist, it becomes necessary for the metallurgist to carefully study the special requirements of his process, and to select from the many substances available those which best suit his working conditions.

Carborundum firesand is a refractory material of comparatively recent application and of growing importance. It is an electric furnace product formed at a temperature of between 6,000 and 7,000 degrees Fahrenheit, and is derived from two of the most refractory materials known to the metallurgist, being chemically a compound of carbon with incompletely reduced silica. Although always carrying a certain proportion of free silica, it should be classed with the neutral refractory materials. Among its physical properties, it may be noted that it has a specific gravity of 2.7, is of greyish green colour, granular, easily crushed, and of low heat conductivity.

One of the most successful applications of carborundum firesand, and one of special interest to the foundryman, is its use in the construction of brass furnaces. In the various types of tilting and rotary melting furnaces now being so extensively introduced among brass founders, the question of linings is very important. Oil fuel has superseded coal or coke, the working temperature is considerably increased, and a corresponding improvement in the refractivity of the lining must be obtained. Unless a lining can be produced which has long life and can be easily renewed, all advantages over the old crucible type of furnace in the matter of fuel consumption and increased weight of charge entirely disappear. A magnesite or chromite lining softens under this extreme temperature. No fire-brick has been found to give satisfactory results, although silica brick has been applied with some success. The most exacting conditions, however, in the matter of resistance to the high temperature of the oil flame and the scouring action of copper and brass slags are fulfilled by the use of carborundum firesand. We have here a material by use of which the entire lining may be rammed up in a solid block, having no joints and presenting a smooth glazed surface of good mechanical strength and great refractivity.

In any furnace structure built of fire-brick, the weakest points are often at the joints. It is the usual practice to make joints of fire-brick as thin and close as possible; but, with the greatest care, these always present to the flame spaces where the volatile fluxes can lodge, and where the slag can scour its way between the bricks, the ultimate result being that the bricks are loosened and the lining destroyed. A most useful property of carborundum firesand is that it unites readily with various binding materials. It can thus be moulded in place in a solid mass avoiding special shaped bricks and the weak feature of joints.

The binder most commonly employed is silicate of soda. This is diluted with water to a thin syrup of a density of about 33 degrees Beaume, and a mixture formed of about 90 parts of firesand and 10 parts of silicate of soda by weight. The constituents, when thoroughly incorporated, form a plastic mixture, which is easily moulded and has sufficient cohesion, when tamped into place, to retain its shape until fired. A centre of iron or wood is provided, the dimensions of which conform to the shape required for the interior of the furnace. The firesand mixture is rammed solidly between the centre and the iron shell of the furnace, and after the removal of centre the lining is dried out with a slow wood fire. The furnace is then brought slowly up to working heat, and can at once be put into service. This method of moulding the entire lining in place has many advantages. The weak feature of joints is entirely avoided. There are no costly shaped bricks required, and it is possible, moreover, to obtain the irregular curved surfaces, which are required for the proper deflection of the flame, for the oil ports and for all orifices.

A further and very important factor is that carborundum firesand has low heat

conductivity. While this would be a disadvantage in a material composing a crucible or a muffle, it is of the highest value in a lining of a receptacle serving at the same time as the combustion chamber and the containing vessel for the molten metal. This is well illustrated by the experience of a well-known manufacturer of tilting furnaces. With fire-brick linings first employed, it was possible to obtain from five to six heats per day. With the first trials of carborundum firesand nine to ten heats were easily run and he expects to reach a still higher efficiency. The exterior of the furnace is cool enough to rest one's hand on the shell, and the plain inference is that the refractory we are discussing is an exceptionally good insulator of heat.

In making up linings for the ordinary type of crucible brass furnace, the mixture consists of 85 per cent. firesand, 10 per cent. silicate of soda, and 5 per cent. of No. 1 fire-clay. A sheet iron form is provided of the same diameter as the interior of the furnace, and the mixture is rammed up between the centre and the shell. This lining will last indefinitely without replacement. It requires, moreover, no skilled labour or special brick in its construction, and when worn can be patched and renewed with the original mixture.

A very useful mortar can be made from carborundum firesand by mixing with it from 30 to 50 per cent. of No. 1 fire-clay. For such purpose a raw fire clay or kaolin will be found well adapted. The mortar is used in laying up fire-brick, in patching up holes or joints which have been scoured out, and for general repair work. When thinned down with water, it can be used as a wash or paint on the face of the fire-brick, protecting them from the action of the fuel and the heated gases. When applied in this way to the silica lining of a Bray melting furnace, the application being made daily, or two or three times weekly, it has been found possible to obtain a life of 1,000 heats without relining.

In conclusion it may be said that the use of this new refractory is not limited to the applications just described, but that experiments are under way which promise that its sphere of usefulness will soon be widely extended.

The sole agents in the United Kingdom for carborundum firesand are Messrs. J. W. Jackman & Company, Limited, of 39, Victoria Street, London, and of Birmingham, Glasgow, and Manchester, who hold large stocks ready for immediate shipment in their Manchester and Glasgow warehouses. We are indebted to them for the interesting particulars given above.

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SOME NOTES ON CUPOLAS.

We extract the following from a recent address on this subject :—

"We all know that for the production of good castings we must have at the start a good cupola, a good blower, good fuel, good iron, a good melter, a good pattern, a good flask, good sand, a good moulder, and a good foreman. If I were asked what I would do in regard to procuring a cupola I would reply that if it was for running off large heats, say 35 tons or over, I would have it built by a reliable boiler maker. The seams and joints should be caulked and the sheets should butt each other and be fastened together by a band around the outside. All the rivet and bolt holes should be countersunk in the inside of the shell and the tuyeres so made as to avoid cutting the firebrick or blocks. The cupola should be designed so that the lining when new will conform to the shape in which it will burn out after continued use.

"My experience has been that the blast striking directly against the fuel is to a certain extent deflected from the centre of the cupola, and finds an easier exit between the fire-brick lining and the fuel and stock. This causes the former to wear out quite rapidly, particularly if there is very much slag.

"The idea of carrying the tuyeres toward the centre of the cupola is not new. It was employed in the construction of the McKenzie cupolas, and gave very good results with lump coal. These cupolas were not very rapid melters, but the iron came very hot.

"The bricks can be kept closely together where there are no bolt or rivet heads to interfere, and thus a longer life is assured to the lining. The further apart the bricks are the more readily the blast attacks them.

"I try to melt as hot and as rapidly as possible, the saving of time in moulding being quite an item, and the addition to the daily output one of the vital points in reducing the cost of production. In the larger shops, where most of the casting is done after the moulder leaves the shop, the overtime of the helpers assisting in the casting can, by rapid melting, be reduced to a minimum. We have just installed a new positive blower, cutting off one-third of the time previously taken in casting."

THE FIRST METAL RAILWAY BRIDGE.—A PRODUCT OF THE IRON FOUNDRY.

Amongst the exhibits in the Transportation Section of the St. Louis Exhibition is a model of the first metal railway bridge, which, some short time ago, was removed from the site which it had occupied for a continuous period of more than eighty years. This interesting "relic" of the early days of engineering—and an illustration of which is reproduced herewith—was built in 1823 for the Stockton and Darlington Railway Company at the western extremity of their original line at West Auckland; it spanned the river Gaunless, a tributary of the Wear, and was in use when the "first public railway" was opened in September, 1825. The bridge was composed of cast and wrought iron in combination, and was the only one of its kind. The bridge is generally believed to have been built from the designs of the celebrated George Stephenson. The piers were cast-iron columns braced together, the bracing bars being connected at their point of intersection. The spans measured 12 ft. 6 in. The frames constituting the girders each consisted of a pair of wrought-iron arched members united by cast-iron verticals which were cast round them. Each frame had thus, it will be seen, to act as a couple of arches, one arch being inverted, since there was no bracing between the verticals. All the shearing forces were, therefore, resisted by the curved members. The cast-iron vertical pillars extended upwards to form a support for the roadway. The ends of the top and bottom members had bosses cast round them, and spigots were made to fit into the top of the column forming the piers. Each pair of columns was connected by a casting which fitted into grooves in the bosses at the ends of the main girders—in short, the general design was such that the structure should fit together like a puzzle.

The First Metal Railway Bridge.—A Product of the Foundry.

The bridges erected prior to the opening of the Stockton and Darlington Railway were either the work of millwrights or architects. It was close to the spot occupied by the old bridge, that on the opening day of the Stockton and Darlington Railway the proprietors assembled and were drawn up the Brusselton incline, a distance of 1,960 yards, in carriages laden with coals and merchandise, in the space of 7½ minutes, not a bad performance for

those early days of engineering. It was, however, with the view to obviating the disadvantages attendant upon this somewhat formidable incline that the construction of the Shildon tunnel was undertaken, from which time the old bridge ceased to carry the "main line" traffic of the Stockton and Darlington Railway, being simply used for the mineral trains from the surrounding district. Consequent upon the developments during the last two or three years in the coal trade of this neighbourhood, and the extension of Messrs. Bolckow, Vaughan & Company's pits, it was found to be necessary to replace the old "relic" with a new structure. By way of comparison, it may be recalled that Stephenson's "No. 1 Locomotive" to carry which the bridge illustrated herewith was erected, had a weight, in running order, of 6½ tons, and a nominal horse-power of sixteen, whilst many of the present standard type of mineral locomotives now used by the North-Eastern Railway have a weight, in working order, very closely approximating 100 tons each.

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THE BULL'S BRIDGE IRON WORKS, Moxley, Bilston, of Thomas Jevons & Sons, Limited, which were closed by the receiver for the mortgagees, will be offered for sale by public auction on November 24.

KELL & COMPANY, LIMITED, has been registered with a capital of £25,000 in £1 shares, to acquire the business of iron-founders carried on as Kell & Company, at Gloucester, and Ross, Herefordshire, etc.

THE STURTEVANT PATTERN SHOP AND PATTERN-HANDLING SYSTEM.

THE STURTEVANT COMPANY now makes and stores its patterns in a building about 148 ft. long by 80 ft. wide, which is divided transversely into two parts, one-half accommodating a flask shop and a pattern shop, being two stories high, while the other half is used as a pattern storage and has intermediate floors, making four stories in all. In the centre of the building is a lift serving all floors.

The flask shop is equipped with band, cross cut and splitting saws, boring machines, and a lathe. Industrial railway tracks from the foundry run directly into this room across a distance of about 40 ft.,

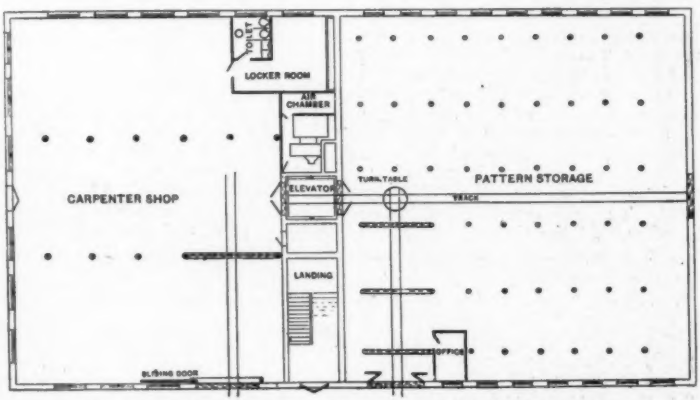


FIG. 1.—PLAN OF PATTERN BUILDING OF B. F. STURTEVANT CO., AT HYDE PARK, MASS., U.S.A.

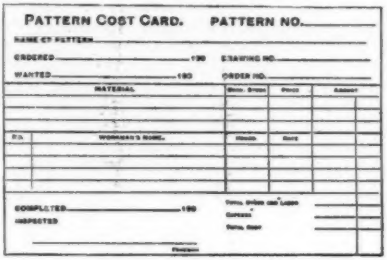
and with an overhead transverse track facilitate the handling of flasks and patterns. In this room there is also a metal pattern department equipped with the necessary machine tools. At the rear are the locker, wash and toilet rooms for the building.

On the second floor is the pattern shop, abundantly lighted on three sides and equipped with a full complement of tools. The benches, each accommodating two men, are arranged along the sides of th building, so that the workmen receive ligh over their left shoulders. The benches are 2½ ft. wide by 16 ft. long, and behind each is a work table of the same length, 4 ft. wide. The benches are supported by cast-iron legs of special design. A drying chamber for glued work is provided, which receives warm air through the

general heat flue from the Sturtevant heating apparatus below.

The first floor of the pattern storage half of the building is of concrete and is intended for the storing of heavy cast-iron patterns. It is served by industrial railway tracks and a turntable for transferring material to the elevator and thence to other floors. Communication between the pattern shop and storage department is direct. The fire risk is reduced by a double system of fire doors. The pattern shelves are supported by cast-iron brackets clamped around the pipe columns which support the floors, and are adjustable to any height. Shelves on the walls afford storage space for smaller patterns.

In connection with the description of this shop the system of handling patterns is interesting. New patterns are numbered consecutively upon the drawings as made. Patterns for grey iron castings take a number without prefix; patterns for brass castings take a number preceded by 0; those for steel have the number preceded by 00, and so on with a different prefix for each material. The numbers are entered in a blotter having columns for date, pattern number, name of pattern, and drawing number. This record is afterward transcribed into the "Pattern Record" book by the record clerk in the drawing office. At the time of taking out a new pattern number a "Pattern Cost Card," Fig. 3, is filled out. This is sent with the drawings to the foreman of the pattern shop, and is an order for him to make the pattern described. The time is kept in the pattern shop and entered on this card, as is also the record of stock used. When the pattern is completed it is inspected by the pattern shop foreman, who signs cost card and enters date completed. The pattern is then sent to the pattern storage, which is under the supervision of the pattern foreman, and the pattern cost card is returned to the drawing room. The pattern cost card is figured by the record clerk, in the drawing office, and filed by pattern number consecutively. The item "expense" is obtained by keeping a record of the total labour in the pattern shop and the total material purchased for the pattern shop. When any work other than pattern work is done a record is kept of the time and material, and the pattern


PATTERN COST CARD. PATTERN NO.

NAME OF PATTERN

ORDERED 190 DRAWING NO.

WANTED 190 ORDER NO.

MATERIAL | Wgt. Each | Price | Amount

No. | WORKMAN'S NAME | Hours | Rate

COMPLETED 190

INSPECTED

Total Labor and Labor Expense

Total Cost

FIG. 3.—PATTERN COST CARD.

shop is given credit. These records give the amount of material and labour chargeable to expense, to which is added depreciation and fixed charges. The whole is then distributed as a percentage on the hours of pattern labour.

When the patterns are delivered to the pattern storage department locations are assigned and records thereof made upon cards of the form shown in Fig. 4, one for each pattern. These cards are filed in the order of the pattern numbers. Four figures, with the addition of a letter, are in every case sufficient to locate a pattern. A given location, for instance, may be 2125B—that is, it is upon the second floor, as shown by the first numeral "2"; it is in the twelfth row of shelves and the fifth division of that row, as shown by the succeeding numbers "12" and "5"; and on the B level, the floor level being designated A, and the letters B, C, D, etc., indicating the shelves in their order above.

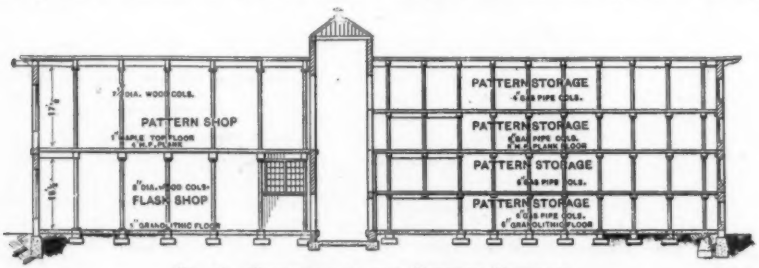


FIG. 2.—ELEVATION OF THE PATTERN BUILDING.

When the foundry foreman receives an order for castings from the office he issues to the pattern storage department a copy of the form shown in Fig. 5 properly filled in. The pattern storage keeper on receipt of this slip refers to the index of pattern cards, Fig. 4, and finds thereon in the

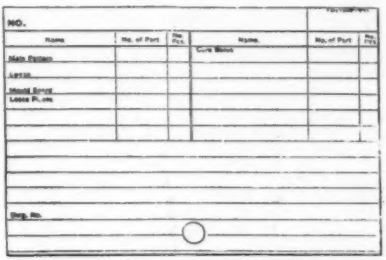


FIG. 4.—RECORD CARD KEPT IN PATTERN DEPARTMENT.

upper right hand corner the location of pattern, which he immediately records upon the slip. The latter he attaches to the pattern and delivers it to the foundry. A metal clip placed upon the corresponding record card in the index file indicates that the pattern is out. When form, Fig. 5,

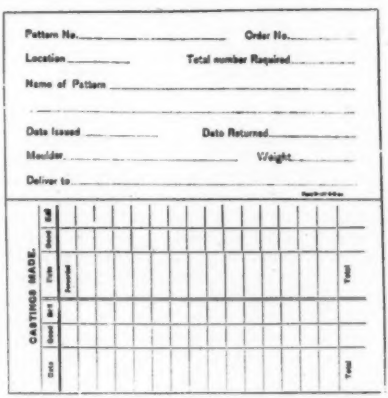


FIG. 5.—SHOWING BOTH SIDES OF A SLIP ISSUED BY FOUNDRY TO PATTERN STORE WHEN A PATTERN IS WANTED.

is filled in at the foundry office a copy is sent to the clerk of the cleaning room, who daily records on the back the number of good and bad castings made from the pattern and keeps the moulder informed as to the number of castings required to complete the order. When the required number of castings are made the pattern is returned to the pattern storage, and the metal clip taken off from the index card. One copy of the slip, Fig. 5, is destroyed, and the other is retained in the foundry office files. We are indebted to the "Iron Age" for the above particulars.

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GOVERNMENT SUPPLIES BOUGHT ABROAD.—A Parliamentary return has been issued of all contracts made by the several Government Departments in the year ending March 3 last, either with contractors outside the United Kingdom or with contractors who obtain the articles from abroad. The Admiralty purchased the following articles:—Electric drills, £21; liquid fuel, £15,000; manganese bronze nuts for boilers, £148; "Naxos" emery wheels, £114; tool steel, £100. The War Office placed contracts for steel castings, £18; steel girders, £79; machine tools, etc., £7,534; electric motors, £3,241; rails and fishplates, £1,125; tools, screw-cutting, etc., £369; wagons, £2,870; emery wheels and rims, £118. Amongst the goods purchased by the Post Office we observe the following:—Spelter, £1,297 10s.; electric light apparatus and fittings, £207 7s. 5d.; tools of special design, £117 17s. 2d.; machinery, £123 7s. 10d.; radiators (for heating), £12 11s. 3d.

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WHEEL GEARING.—At a meeting of the Birmingham Institute of Mechanical Engineers, held recently, Mr. W. H. Thornbery read a paper on "Wheel Gearing," in the course of which he said that all classes of engineers were anxious to get the maximum of power at a minimum cost. For a long time after the introduction of steam power toothed gearing was universal, power from the main shaft being derived by means of spur gearing. This was later superseded by wide belts, more recently by cotton belts, but to-day toothed wheels had superseded that method. Cut gears could attain a very high speed if accurately made. The author's arguments went to show that wheel gearing, when properly understood, tended to lengthen the life of machinery very considerably, whilst breakages were few—in short, where an engineer was a master of that branch of machine work, there was a great saving of labour and capital, and increased output and more satisfactory results all round were obtained.

FOUNDRY AND FACTORY SYSTEMS.*

By Kenneth Falconer.

We hear a great deal in these days about specialism and concentration of effort, and while modern conditions have undoubtedly made these essential to any great measure of industrial success, yet, like many other good things, it is possible to carry them to excess—to over-reach the mark.

Some few years ago, a writer expressed the view that cost keeping is only—I use his own words—"a detail in the larger question of factory or industrial organisation, which question must be solved before any solution of the other can be made." Any system of cost finding designed for use in foundry and planned without regard to conditions except those directly affecting cost of product—while it may supply accurate records of costs, will yet fall far short of what may fairly be looked for from it had it been designed on broader lines and as a part of a greater scheme. In cases where the foundry is but one department of productive organisation, any system of accounting designed without consideration of the needs and workings of the other shops, while it may be in itself a very perfect system of foundry accounting, will yet not be the factor towards the general success which it should.

The essential difference between cost finding and factory or foundry accounting in systems lies rather in the scope of their work than in the direction of their aims. The latter includes, but is much more than, the former. The ultimate object of both is cost reduction, and both are efficient and valuable in direct proportion as they make for that end. In the article to which I have already referred, the author gives the following as to what may properly be expected of a system of cost keeping; final costs—of completed units of products at the door of the factory; final costs in which to factory costs are added all commercial and selling costs; partial costs, or costs at various stages of production; comparative costs, both of different periods, and of like articles manufactured under different conditions and indirect costs by classes and groups.

The fundamental importance of specialised methods of accounting in various branches of commerce is generally admitted. Their direct bearing on the ultimate result has until recently been less generally recognised in the foundry than in many other industries.

Generally speaking, cost of product must be looked for along one or both of two main lines—either by making each individual article or group of articles manufactured the subject of individual records during manufacture, or else by finding the cost of certain operations and ascertaining the relation of that cost to such part of the product as has undergone each, either according to weight, measurement, or some other known factor. Cost finding in the foundry requires both these lines of research and record.

That conditions existing in the foundry and the processes connected with the manufacture of its output render the problem of costs more complex than in some other lines of manufacture, is true. The general principles of cost accounting, however, apply to all productive work, and it is only in the method of their application that there is any difference between cost finding in the foundry, and in, say, a machine shop building one machine only and that always of uniform size and type. To offset the admitted difficulties in the way of finding the cost of foundry product it possesses one point which tends to simplify the question, namely, that the cost reduced to per hundred pounds, either of the entire output, or some part of it, is the final touchstone to which must be applied all details of the cost of castings, whether in the shape of expenditures for material, direct wages, indirect costs, or manufacturing expenses.

Elements in Foundry Cost.

In common with all other manufactured output, the cost of castings is composed of three elements, wage cost, that is the wages paid for its manufacture; material cost, or the cost of the material of which it is formed; and indirect cost, or expenditures incurred for the production of output not chargeable directly to the cost of individual articles or group of articles, but distributed either on all or on certain defined classes or kinds of the product. The proportion of the last-named element to the total cost of product is possibly greater in the foundry than in any other line of manufacture, and it is in this element of cost almost invariably that will be found the greatest opportunity for cost reduction. The material cost of castings is largely governed by ruling market prices, subject, of course, to local conditions. The wage cost is largely regulated by organisations and influences distinct from and independent of either workman or employer; the indirect cost is largely

* Abstract of an address to the members of the New England Foundrymen's Association.

in proportion to the efficiency of the management. It is in this light that a factory or foundry system is as direct an influence for cost reduction as either an improved plant or better manufacturing methods. The latter make for increased output; the former should afford detailed knowledge and periodical comparison of all details of cost both direct and indirect, and indicate the relation between effect and cause as the ratios may change between such items. Up to a certain point opportunity for cost reduction is in direct proportion as the various items going to make up indirect costs or manufacturing expenses are known in detail, susceptible of analysis and periodical comparison, and, more important still, as it is possible to trace the relations between cause and effect as the ratio of any expenditure or expense to some known factor of the output may vary. For its highest efficiency, a cost system should provide complete and detailed records of those thousand and one expenses which constitute part of the cost of product and which, though possibly trivial in themselves, are of the greatest moment in the relation their aggregate bears to the output for a given period.

One point which makes very strongly for or against the efficiency of a cost system, is the promptness and regularity with which the information procured by it is supplied. In one cost system I have in mind, conditions are such that the essential requirement placed before all else, was that the cost of finished articles should be known the day after they were completed. It is, however, as regards indirect cost of product and the expense of operating and maintenance, essential that results should be promptly and regularly available for examination and comparison.

Another important question, and one which does not always receive the consideration it deserves, is how best to arrange the information secured so as most graphically to present the conditions existing, and most forcefully indicate their cause. Many otherwise efficient systems, carefully planned and conscientiously carried out, lose much of their value because the information they secure is arranged solely with the idea of showing amounts and values without the slightest consideration of their relations, ratios, or proportions. The value of periodical reports is often sacrificed to uniformity. For instance, the amount of non-productive labour in a certain shop or of fuel consumed in the foundry, if shown in conjunction with the total labour in that shop, and with the weight of castings produced for a given period, will convey more meaning than if the same figures appear merely as details of wages, of fuel consumed, and of castings manufactured. Amounts and values should be so presented as to serve the purpose of record, and in addition to act as a guide to subsequent action or later transactions. "Costs have no value except in comparison, that action may be directed by experience."

The Graphic Method.

It is, of course, impossible to make any general rule regarding the make-up of periodical reports and statements.

The value of basing curves and diagrams on proportions and percentages is evident when the meaning and value of the information to be recorded depends largely upon its relation to other items. To express it briefly, parallel columns of figures show results and afford opportunity for comparison. In the same direction curves based on gross amounts are of equal value, and in addition to making the differences more noticeable, they force attention to the general tendency of the results. Curves representing percentages and proportions, if properly planned and carefully executed, afford equal opportunity for comparison, are equally insistent in forcing attention to differences and to the general tendency of the results and to a greater extent than might be thought, will indicate the relation between cause and effect.

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FOUNDRY DRIVEN BY BLAST FURNACE GAS.—In giving evidence recently Mr. M. Deacon observed that a gas-engine plant for generating electric power has been for some time successfully in use at the Sheepbridge Iron Works. There are two engines, having cylinders 22 in. diameter, and 3 ft. stroke, each nominally 100 h.p., but working when required up to 140 h.p. These drive two continuous current dynamos 92 h.p. each, which provide the power for driving the cranes, loam mills, blowers, fans, fitting-shops and other engines, in connection with a large cast-iron pipe foundry. The blast furnace gases are passed through a small purifying plant, consisting of a washer, condenser, and baffle, and coke saw-dust scrubbers. The cost of the plant per i.h.p., exclusive of the generators, amounted to £14. The cost of a steam plant, including the necessary boilers and engines, would be £28 per i.h.p. The gas engine plant being a pioneer plant, was, however, obtained on very favourable terms.

GRAPHITE IN THE FOUNDRY.

From a pamphlet issued by Messrs. G. G. Blackwell, Sons & Company, Limited, of Liverpool, on the uses of graphite, we take the following:—

Those manufacturing quantities of castings have found, on various occasions, the finest, best made, and most expensive castings are spoiled by what is known as "cold" shuts and blisters, caused through a bad quality of blacking or plumbago facing being used. Brass founders, more than any other firms, particularly require a finely powdered quality of graphite, absolutely free from grit, and one which, when coming into contact with the molten metal, will not give off too great a quantity of carbon dioxide, which would spoil the face of the castings.

Sometimes you want to make castings for very special work. This may be a little out of your ordinary line, and yet it would pay you to make them. For this work, of course, you will require a very special quality of graphite, and for which probably you would be prepared to pay a trifle extra. In cases of this sort, the special quality should be obtained. Many iron founders have a demand for the rougher and more common forms of castings, and for this purpose do not require such a good quality of graphite.

Graphite is put on the facing surface of a mould for the purpose of preventing adhesion to the metal of the sand in which it is cast. A graphite facing saves cleaning of the castings, and gives them a far better appearance.

When a properly prepared graphite facing is used, the surfaces are very much easier to work when the castings are sent to the machine shop. Wherever the molten metal burns into the sand of the mould, it causes hard spots on the castings, which quickly dull the edges of the cutting tools.

The reason why graphite makes a better casting, and prevents hard spots, is as follows:—

Graphite is one of the forms of carbon, and is a combustible material. Now, when the molten metal is poured into the mould, the air in the mould and the air carried in by the stream of melted metal, furnish oxygen enough to bring about a certain amount of combustion, forming a gas between the metal and the mould. The outer portion of the facing begins to burn, and a film of gas to form between the facing and the iron. This effectually prevents adhesion of the metal to the sand; and as long as this gas film exists, there is no adhesion of the sand, and, consequently, no spoiled castings.

It must, however, be borne in mind that whilst the facing must burn to be effective, yet at the same time, if it burns too much—that is, gives off too much gas—immediately difficulties are created. A proper facing will adhere perfectly to the sides of the mould, and will burn and form gas in a regular manner—that is, burn sufficiently to produce a film of gas referred to above.

The ordinary run of cheap coal facings cannot give satisfaction, as they do not work properly. They generally run before the molten metal. Some facings are not sufficiently adhesive to the sand mould surface, and the hot iron coming in contact with them immediately dries out the sand, and if unsuitable facings are used, they run and leave the mould surface bare. This is one reason why a number of facings are required.

Some firms prefer a soapstone facing as being best suited to their particular requirements. Many foundrymen use such a "cream facing" by itself, but the majority use it in conjunction with the graphite, thereby reducing the cost of the graphite, whilst, at the same time, they obtain equally good results. This is also known to the trade as boffin flour, etc.

On work that has to be nickel-plated, it has no equal, as platers find it much easier to plate a light coloured casting. If your heavy facing will not permit sliding, owing to its sticky qualities, a little soapstone mixed with it will help it very much.

—o—

It is interesting to learn that in Russia at present, in addition to the producers of railway material, the engineering works and founders which turn out warlike products are also well employed. The war arrived at an unfortunate period for the Russian iron industry, because of the slight improvement which took place during the latter portion of 1903 in succession to the severe depression of the few preceding years. It would seem, however, from the large capacity of the Russian works as compared with the actual demand, the extension schemes in hand in various districts, and the effects of the war upon industry in general, that a repetition of the crisis of a few years ago is probable in the near future. The dislocation of trade, although carefully contradicted from time to time, is gradually being recognised even by some of the leading Russian newspapers, and the reported enquiry to be undertaken by the Government lends apparent confirmation to the assumption of forthcoming depression.

DRY BLAST FOR CUPOLAS.

In a valuable paper read before the Iron and Steel Institute, Mr. James Gayley suggests the desiccation of air before its entry into the blast furnace. He also points out that the great economies to be thereby obtained apply also to the cupola, the open-hearth furnace, and to the Bessemer converter. Although Mr. Gayley's paper refers entirely to blast furnaces, and has therefore only a small bearing on cupola practice, we extract such portions of it as may be applicable:—

The desiccation of air to such extent as to cause a practical elimination of the moisture, or its reduction to a small quantity, and maintaining it uniform, must of necessity contribute in a very marked degree toward the attainment of uniformity in the furnace operations, and the advantages from desiccation can be appreciated only after due consideration is given to the volume of air that is consumed per minute and the large amount of moisture which it contains.

Many are probably not aware of the amount of water that enters the furnace. Observations show that the average monthly content of moisture in the air at the furnaces, the observations being made at 9 a.m., varied from 7.1 in June, July, and August, to 5.4 in September, 4.7 in May, and 2.8 to 3.2 in the other months. These figures being grains of water per cubic foot of air. It is true that the atmosphere has been recognised by many metallurgists as the cause of many and serious irregularities, but it is doubtful if its influence has been adequately recognised. Many writers on metallurgical subjects have considered the moisture in the atmosphere, and calculated the absorption of heat necessary for its dissipation—and invariably under estimated; and have dismissed the subject with the conclusion that to extract the

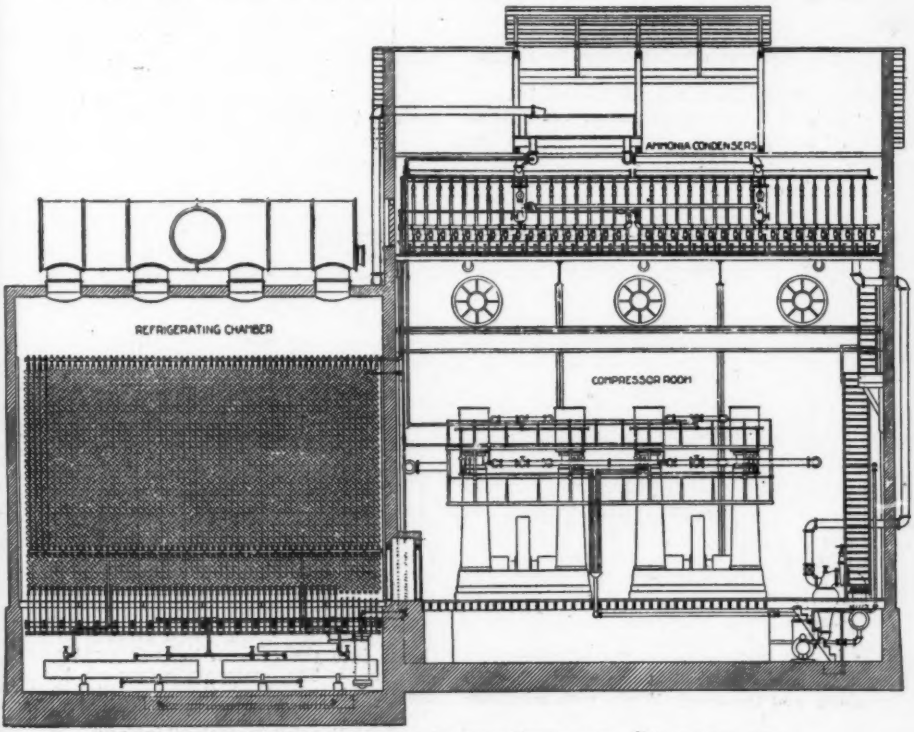

FIG. 1.—SECTIONAL ELEVATION OF AMMONIA COMPRESSORS, CONDENSERS, AND REFRIGERATING CHAMBER.

moisture the game was not worth the candle.

Of much greater importance is the variation in moisture from time to time and the margin of heat carried in the furnace to compensate for these variations, which margin is invariably large; and every furnace manager is aware of its existence, from the way in which he is required to manipulate the hot-blast temperatures, and from the silicon in the metal, which is the thermometer of the hearth. It has often been a matter of surprise that a greater saving of fuel per ton of iron was not obtained in the winter, as compared with the summer season, as the records show a much less content of moisture in the atmosphere, the reason being that in summer the windows and doors of the blowing-engine room are wide open, and the supply of air, with reference to humidity, is practically that of the atmosphere; but in winter they are nearly or quite closed, and the entering air has mixed with it all the steam that leaks from the engine. Uniformity is what is required.

Various schemes for absorbing the moisture were worked out and in turn abandoned, and refrigeration by means of anhydrous ammonia was chosen. In Fig. 1 there is shown in elevation the ammonia compressors, condensers, and the refrigerating chamber ultimately used. This view of the refrigerating chamber shows it to be connected for the direct expansion of ammonia, but as the escape of ammonia gas through a broken pipe or leaking joint might imperil the life of anyone in the chamber at the time, it was decided to adopt the brine system. The refrigerating chamber is lined on the inside with plates of compressed cork 2 in. thick.

Fig. 2 shows the brine tank, in which are twenty coils of pipe of the dimensions shown in the diagram. The coils are covered with calcium chloride brine. The return brine from the refrigerating chamber flows into the top of the tank, is cooled by the ammonia expanding between the outer and inner pipes, withdrawn therefrom by a pump and forced back through the pipe marked "brine inlet" into the 2-in. or inner pipes, where it is cooled below the freezing-point, and

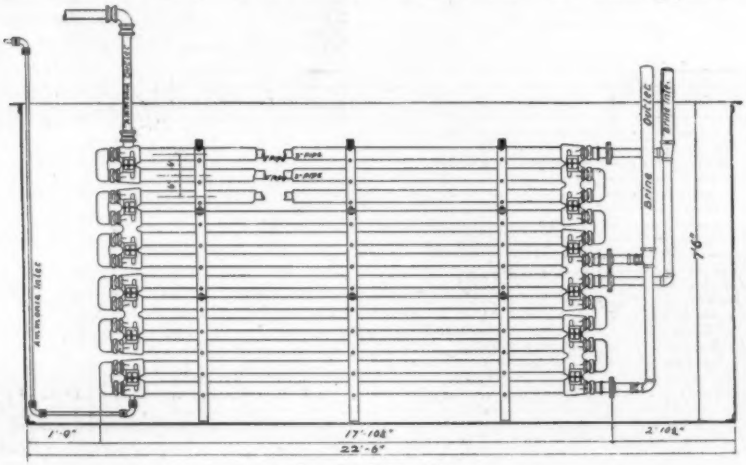

Fig. 2.—Brine Tank.

thence into the coils in the refrigerating chamber. The ammonia enters at the bottom of the pipes, thus travelling in the opposite direction from the brine, and by expanding between the 2-in. and 3-in. pipe cools the brine both in the tank and in the inner pipes.

There are in each vertical line of coils seventy-five 2-in. pipes 20 ft. long, and in the chamber there are sixty vertical lines of coil, the whole representing 90,000 lineal feet of 2-in. pipe in the chamber. The pipes in each vertical coil are placed in staggered position to insure better contact with the air. The series of coils is divided into three sections and fed through a 4-in. header, and discharges into a 6-in. header, thence into a stand-pipe, from which the brine flows to the brine-tank, its feed being arranged to cause the brine

to flow in a direction opposite to that of the air. As the space between the pipes would become gradually reduced through the accumulation of frost, which might diminish the efficiency of the blowing-engine, a blower was installed to force air into the refrigerating chamber, and in order to secure a uniform distribution of air over the coils revolving electric fans (marked A and B) were placed in the space underneath, so that all of the coils would frost alike. The entering air deposits the moisture as frost, and passes from the top of the chamber to the blowing-engines at a temperature of freezing or below and with a practically uniform content of moisture. When the pipes become covered with frost, steam is forced through, and in a few minutes the frost is melted. Connection is then made with the cold brine

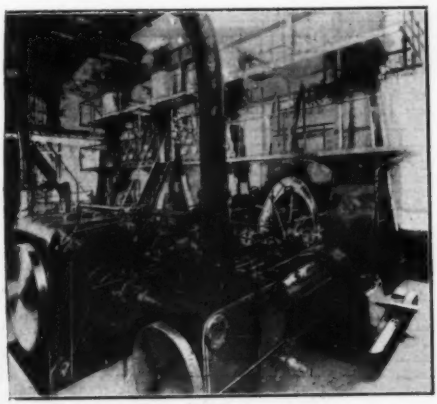

FIG. 3.—AMMONIA COMPRESSORS.

system, and frost begins to deposit quickly. The frost which has been melted off collects in a trough and flows off.

In Fig. 6 there is graphically set forth the record of furnace operations from August 1 to September 9 inclusive. This shows the increase in output and reduction in coke consumption corresponding to the increase in burden. There is also shown the varying conditions of humidity from day to day, and the change in humidity after being treated in the dry blast apparatus. During this time the coke consumption per ton was 1,726 lbs., as against 2,147 lbs. without dry-blast. During a period of thirteen days the average moisture in the atmosphere was 5.66 grains per cubic foot, and in the dry air 1.75 grains. Sixty-nine pounds of water were removed from the blast per ton of iron produced, which represents an average of 23,192 lbs. (equivalent to 2,784 gallons) for the twenty-four hours. As the dry-blast was supplied to the fur-

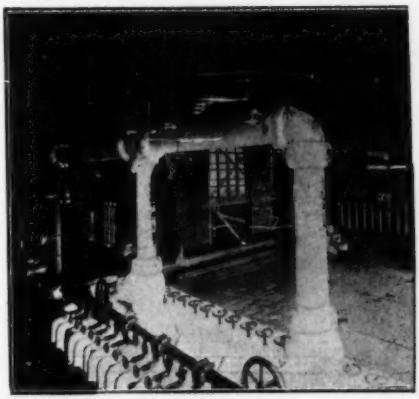

FIG. 4.—BRINE COOLING TANK.

nace it became necessary to reduce the revolutions of the blowing-engines, since the air supplied to the engines was lower in temperature than with the natural atmosphere and contained more oxygen per cubic foot, and the tendency of the furnace was to drive too fast. With dried blast, 96 revolutions per minute of the

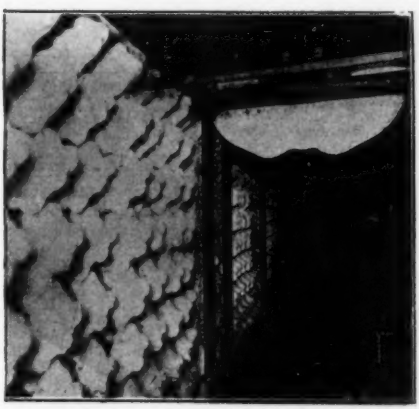

FIG. 5.—REFRIGERATING CHAMBER, SHOWING FROSTED ENDS OF COILS.

blowing-engines burned nearly 1 per cent. more coke and produced 89 tons more pig-iron in twenty-four hours than 114 revolutions on natural air.

The saving effected in the blowing-engines through a reduction in the number of the revolutions, has an important bearing on the expenditure for power in operating the machines in the dry-blast plant. Prior to the use of the dry-blast plant, the blowing-engines were indicated at 900 i.h.p. From the cards taken when the furnace was supplied with dry-blast, the average i.h.p. was 671, a difference of 229 h.p. per engine, which aggregates 687 i.h.p. for the three engines. The ammonia compressors and fans, together with the brine and water-pumps, take a total of 535 h.p. Comparing this with the power saved in the blowing-engine room, there appears an excess above that required for operating the dry-blast.

The application has shown, in addition to the economies effected, that the furnace can be operated with precision; it works with greater regularity, and in consequence the product is uniform with respect to grade and composition, which makes the dry-blast of particular value in the making of foundry iron, which is marketed by grade.

The figures given above apply, of course, to a large blast furnace plant. If the system should ever be applied to cupolas the size of the apparatus would be infinitely smaller. There is, however, not much likelihood of its being applied to foundry work, because the saving is so much smaller. One excellent lesson is, however, to be learnt from the paper, and that is that care should be taken in arranging the air inlet for the blower, to see that it is free from any steam and is as uniform as possible.

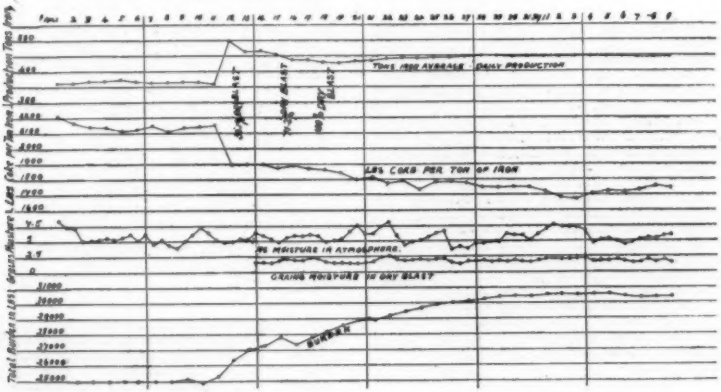

FIG.6.—DIAGRAM OF BLAST FURNACE OPERATIONS FROM AUGUST 1 TO SEPTEMBER 9.

THE FOUNDRY IN POPULAR MAGAZINES.

THE popular magazine seldom deals with the foundry, nor do moulders often figure as writers of magazine literature. Yet, Mr. Benjamin Brooks' article on "The Moulders" is the feature in SCRIBNER'S for October, and both artist and writer have invested the subject with a singular charm, as the few random extracts given below will indicate:—

In another place lay the long fin-like blade of a ship's propeller, varnished and polished like a piece of furniture; and a painstaking old workman bent over the impression of it which he had taken in the earth, smoothing it with a tiny trowel, dusting it over with sprinklings of plumbago, and polishing it with the flat of his rough hand till it looked as smooth and glossy as an ice pond. Beyond, in a deep pit, a crouching gnome with a short clay pipe in his mouth was building up a circle of bricks like a well-curbing, stuffing mud and straw into the chinks, lining it with earth carefully smoothed and polished. This was to give shape to the engine cylinder of some gallant liner of the near future. In another department men were compounding unusual shapes out of flour and clay and water mixed together and pressed into wooden forms, which they piled upon a car and ran into an oven as big as a small cottage, till they were baked hard. And these "cores," as they called them, were to be laid within the sand moulds to form the inside hollow places in the iron where required. So upon every side things were

happening at the same lively rate, and from the great variety of the limbs and skeletons of future machinery that lay about, I concluded the foundry was the beginning of all things metallic—and this was not so very wide of the mark; for to go into a foundry is to go back to first principles in mechanics, where the ordinary common things we use and depend on every day, with no thought of their origin, are fashioned out of the elements of the earth.

It is very hard to say where the moulder leaves off and the sculptor begins. There is, to be sure, a lot of humdrum about it. A man will often be found making twenty moulds a day from the one pattern, and doing the same for months together, till his tools wear out in his hands. He works automatically, without zeal or joy in the task, and whether the monotony makes the man or the man chooses the monotony is not easy to say. Most of them, at any rate, fight against routine. They roam over the map with a happy-go-lucky assurance of a job, until they have become too valuable to set at one task to work without thought. Delightfully free and sailor-like it is to go where one will, seeing the cities of the world like a gentleman tramp, with one's office under his hat, with one's livelihood in one's hands, and money in pocket. Yet I believe the artist rather than the vagabond is uppermost with them.

There is usually room at the top for moulders, for in contrast with the routine is the work that requires great skill and judgment—like the ocean greyhound's cylinder, for instance, that takes two weeks to make; and beyond that again are the fellows that cast the great chimes—five tons of metals in one bell, mixed and compounded with the care of an alchemist, true to the ear and without a single flaw. The bronzes on the Capitoline, the satyrs that were dug up at Pompeii—these also are moulding; and old Bartolommeo Colleoni, riding his famous bronze steed through the square in Venice, is enough to make every moulder proud of his trade. It is a very ancient, respectable art, and has never declined like many others.

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WILLANS & ROBINSON are to take up the manufacture of the Diesel engine. This is under a manufacturing arrangement with the Diesel Engine Company, Limited, of 179, Queen Victoria Street, London, E.C., with whom the selling rights remain, and who will deal with all enquiries.

AMERICAN PRODUCTION OF STEEL CASTINGS.

THE total production of open-hearth steel ingots and castings in the United States in 1903 was 5,837,789 gross tons, against 5,687,729 tons in 1902, an increase of 150,060 tons, or 2.6 per cent. As compared with 1898, six years ago, when the production of open-hearth steel amounted to 2,230,292 tons, there was an increase in 1903 of 3,607,497 tons, or over 161 per cent. In 1902, 4,496,533 tons of open-hearth steel were made by the basic process, and 1,191,196 tons were made by the acid process, while in 1903 the production by the basic process amounted to 4,741,913 tons, and by the acid process to 1,095,876 tons. The total production of open-hearth steel castings in 1903, included above, amounted to 384,809 gross tons, of which 134,879 tons were made by the basic process and 249,930 tons were made by the acid process. In 1902 the production of open-hearth steel castings amounted to 367,879 tons, of which 112,404 tons were made by the basic process and 255,475 tons by the acid process.

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PIG-IRON EXPORTS.—In the matter of pig-iron exports, Great Britain holds a pre-eminently leading place, but not quite so much so as she did a few years ago, since Germany added this to her other advancing exports. The figures for the first eight months of the year have been as under :—

Exports of Pig-Iron.

	1903. Tons.	1904. Tons.
Germany	311,773	155,289
Belgium	17,412	18,543
France...	134,617	114,354
Great Britain ...	770,613	554,862
Total... ...	1,234,415	843,043

The predominant place here is occupied by our own country, with 62 per cent. of the total in 1903, and 65 per cent. of the total in 1904. It will be noted that the total decline in the four countries in 1904 was 391,367 tons.

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FIVE furnaces out of six are at present blowing at the Govan Iron Works, Glasgow, of William Dixon, Limited. The other furnace is being re-built or re lined.

TRADE TALK.

THE CONSETT IRON COMPANY, LIMITED, have removed their Newcastle offices to 118, Pilgrim Street.

THE STIRCHLEY IRON COMPANY'S works at Dawley, Salop, will be offered for sale by public auction on Thursday, Dec. 1.

MESSRS. HODGSON, WRIGHT & WOOD, have now taken possession of their new Century Works, Pellon Lane, Halifax.

THE KEY ENGINEERING COMPANY, LIMITED, have removed their London offices to 4, Queen Victoria Street, E.C.

W. SISSON & COMPANY, LIMITED, has been registered with a capital of £25,000 in £1 shares. Office: Quay Street, Gloucester.

THE WOLVERHAMPTON CORRUGATED IRON COMPANY, LIMITED, have resolved to erect new works at Ellesmere Port, Cheshire, at a cost of £50,000.

THE METROPOLITAN AMALGAMATED RAILWAY CARRIAGE AND WAGON COMPANY'S registered offices have been transferred to Saltley, Birmingham.

NETTLEFOLD, LIMITED, has been registered with a capital of £10,000 in £1 shares, by Mr. Arthur Keen, Mr. E. Nettlefold, and others.

MESSRS. W. RUNTON and G. THOMPSON, engineers, Kingston-upon-Hull, trading under the style of Runton & Thompson, have dissolved partnership.

SAMUEL PLATT, LIMITED, has been registered with a capital of £50,000 in £1 shares. Office: King's Hill Foundry, King's Hill, Wednesbury.

MESSRS. J. W. SYKES and E. SYKES, iron and brass founders, Guiseley, near Leeds, trading under the style of J. W. Sykes, have dissolved partnership.

THE DUNNIKER FOUNDRY, Kirkcaldy, was recently the scene of a fire, originating in a shed adjoining the drying stove, but the damage was not serious.

MESSRS. F. W. BARKER and A. S. ASPEY, engineer, etc., of Kingston-upon-Hull, trading under the style of Barker & Aspey, have dissolved partnership.

MESSRS. J. A. MILLEN & SOMMERVILLE, of the Tradeston Iron Works, have secured the contract for the steel roofing for Messrs. Singer's new power-house at Kilbowie.

THE STAVELEY COAL & IRON COMPANY, LIMITED, have established an office at 34, Victoria Street, London, S.W., where the firm's business in iron pipes will be conducted.

THE WORTHINGTON PUMP COMPANY, LIMITED, of 153, Queen Victoria Street, London, E.C., have purchased the European business of the Blake & Knowles Steam Pump Works.

THE MOUNT VERNON IRON AND STEEL COMPANY'S steel foundry, at Shettleston, Lanarkshire, is being offered for sale by private treaty. The ground extends to about 1 acre 3 roods 23 poles.

MR. R. H. HAYLOCK, of 63, Queen Victoria Street, E.C., has been appointed sole agent for London and the South of Mr. G. Addy, Waverley Works, Sheffield, for the sale of his "Z" brand high-speed tool steel.

THE GLOBE PNEUMATIC ENGINEERING COMPANY, LIMITED, has been registered with a capital of £62,500, in £1 shares, to acquire from the Philadelphia Pneumatic Tool Company, of Philadelphia, certain patents.

A RECEIVING order has been made in connection with the affairs of Mr. S. Martin, sen., and Mr. S. Martin, jun., iron-founders, of Willenhall, Staffordshire, who traded under the style of S. Martin & Sons.

THE RENSHAW IRON WORKS have had only one furnace in blast. Extensive alterations are being made, and the men who have been employed at the furnaces are engaged on these. The moulding shop has been closed.

T. C. WILLIAMS & SONS' engineering business at London Street Ironworks, Reading, has been acquired by Callas, Sons & May, Limited, of Reading, with the exception of the foundry plant, patterns, and goodwill.

GREEN & BOULDING, engineers, 28, New Bridge Street, London, E.C., have converted themselves into a limited liability concern under the name of Green & Boulding, Limited. Mr. S. Boulding will act as managing director.

MESSRS. C. W. BURTON, GRIFFITHS & COMPANY, of 1, 2, and 3, Ludgate Square, London, E.C., have been appointed the British representatives of the Thos. H. Dallett Company, pneumatic tool manufacturer, etc., of Philadelphia.

MESSRS. BARRY, HEAD & COMPANY, of 26, Lombard Street, E.C., have been ap-

pointed sole London agents for the Denby Iron and Coal Company, Limited, and are now offering the company's "D. D. D." and "D. B. B." brands of pig-iron.

THE GLENGARNOCK STEEL COMPANY, LIMITED, have secured premises at Cubitt Town, London, E., and have placed them under the management of their London agents, Messrs. Rogers, Twentyman & Company, of Leadenhall Buildings, E.C.

JOHN BROWN & COMPANY, LIMITED, of the Atlas Steel and Iron Works, Sheffield, are presenting a petition to His Majesty in Council praying that the Letters Patent for their invention of improvements in steam boilers and furnaces may be extended for a further term.

LAMBERT'S OLD FOUNDRY, Swansea, was last week offered for sale by auction. The site has passed into the hands of the Harbour Trust for a new dock, but the effects have been disposed of elsewhere. Sets of foundry boxes went from 41s. a ton to 45s. The latter price was received for a quantity of flooring plates.

MESSRS. BALCKE & COMPANY, condenser specialists, who were formerly represented in this country by Mr. Arthur Koppel, have now opened a branch under their own name at 27, Clement's Lane, London, E.C. Mr. C. Schmidt, who has been with this firm for many years, has been appointed London manager.

THORNYCROFT & COMPANY, LIMITED, have secured the sole rights of manufacture, for marine purposes, of the smaller sizes of the Capitaine gas producer, while Beardmore & Company, Limited, of Glasgow, have taken up the sole rights for manufacturing the larger sizes for Great Britain and the Colonies.

THE AUDLEY ENGINEERING COMPANY, of Newport, Salop, have acquired the whole of the assets of Wheatcroft, Limited, and the Haskew Walton Company, Limited. In future Mr. H. A. Saunders, late of Baldwins, Limited, will act as general manager of the works, Mr. A. Raber as consulting engineer, and Mr. H. Wheatcroft as works manager.

AT the adjourned meeting of the creditors of the Stevenson Metal Company the offer of Mr. Ellis was finally rejected, and a resolution was adopted, "That the partners in the firm of the Stevenson Metal Company be adjudged bankrupt," leaving it to be decided who the partners are. Mr. A. J. West was appointed trustee, and a committee of inspection elected.

FERRANTI'S, LIMITED, are being reconstructed. Mr. J. M. Henderson, chairman, explained that after meeting all the costs incident to the Court proceedings which had taken place, the resuscitated company would start with a working capital of about £20,000. The capital of the new company would be £130,000, divided into 60,000 preference shares of £1 each, and 10,000 deferred shares of £1 each.

—o—

COMPANY NEWS.

DUNDEE SHIPBUILDERS' COMPANY.—Dividend of 5 per cent.

THOMPSON & SOUTHWICK.—Net profit of £816 1s. 9½d. for the year.

PARKGATE IRON AND STEEL COMPANY.—Interim dividend of 6d. per share.

THOMAS SMITH'S STAMPING WORKS.—Net profit, on a capital of £100,000, of £178.

RICHARDSONS WESTGARTH, & COMPANY.—Profit, £74,503 3s. 3d. Dividend of 6 per cent. per annum on the ordinary shares.

HOZIER ENGINEERING COMPANY.—Dividend of 50 per cent. per annum on the ordinary shares, making the total return for the year 35 per cent.

IRON TRADES EMPLOYERS' INSURANCE ASSOCIATION.—Loss of £5,756. The number of firms has increased, and is now 105, showing an average premium per firm of £109. Claims again show an increase, being nearly 45 per cent. of the number of accidents, as against 42 per cent. last year.

FLEMING & FERGUSON.—Mr. Fleming, who presided, stated that the works had been profitably employed during the past financial year, and that, with the orders in hand, the company can confidently look forward to the current year showing equally good results. He moved the dividend on the ordinary shares of 5 per cent., making, with interim dividend, 10 per cent. for the year.

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OBITUARY.

MR. W. JAMES, late chief constructor at Chatham Dockyard. Age 56 years.

MR. ROBERT KERR, director of F. Reddaway & Company, Limited, of Manchester.

MR. JOSEPH SMITH, of Walker & Smith, machine makers and ironfounders, Batley. Age 75 years.

MR. C. F. FOSTER, managing director of the firm of Messrs. Foster, Blackett & Wilson, Newcastle-on-Tyne.

MR. J. H. BEECROFT, of Horsforth, a member of the firm of Messrs. Beecroft & Company, engineers, Leeds.

MR. ALFRED SMITH, of the firm of Messrs. Smith & Grace, ironfounders, Thrapston. Age 50 years.

MR. T. MILLBURN, secretary for Messrs. Locke, Blackett & Company, lead manufacturers, of Newcastle-on-Tyne.

MR. CARL ERNST BETRAND, inventor of the Betrand-Thiel process of steel manufacture.

MR. D. STEWART, of D. Stewart & Company, Limited, London Road Iron Works, Glasgow. Age 60 years.

MR. W. MALIPHANT, the builder and designer of the new steel works that have just been erected by Messrs. Richard Thomas & Company.

MR. L. WOODWARD, managing director of the firm of Messrs. Moses Mellor & Sons, Limited, machine makers, of Nottingham. Age 71 years.

MR. L. BRIERLEY, of Edgbaston, Birmingham. Some few years ago Mr. Brierley became chairman of the Patent Shaft and Axle-tree Company, Limited, and for some time he also acted in a similar capacity in connection with the Midland Railway Carriage and Wagon Company, Limited. He also part owned the business of Messrs. John Webb & Company, brassfounders, Birmingham. Age 77 years.

PERSONAL.

SIR LOWTHIAN BELL, Bart., recently underwent an operation for cataract.

SIR ALEXANDER WILSON is about to resign his position as chairman of Cammell, Laird & Company.

MR. MALCOLM DILLON, manager of Palmers' Works, Jarrow, has been re-elected Mayor of Jarrow.

MR. G. BEECH has been elected a director of the Birmingham Railway Carriage and Wagon Company, Limited.

THE late Mr. William Rhodes, of J. Rhodes & Sons, Limited, Wakefield, left estate of the gross value of £52,885 3s. 8d.

DR. J. H. GRINDLEY has been appointed Lecturer in Engineering in the University of Liverpool. Mr. A. Leitch has been appointed assistant Lecturer in Engineering.

THE late Mr. Joseph Robinson, principal in the firm of J. Robinson & Sons, and chairman of the Tyne Iron Shipbuilding Company, left estate of the gross value of £109,576.

MR. A. H. BURGESS has been appointed to represent the Pearson & Knowles Coal & Iron Company, Limited, in the Birmingham district, in the place of the late Mr. A. G. Tait.

MR. P. B. BROWN, who has, for sixteen years, been works manager of Hadfield's Steel Foundry Company, Limited, of Sheffield, has been appointed their representative in London.

MR. J. C. HAY, of Messrs. A. A. Laird & Company, has been appointed shipping commercial manager for the Carron Company, with headquarters at 125, Buchanan Street, Glasgow.

THE late Mr. Friedrich A. Siemens, inventor of the regenerative furnace, and co-founder with his brother William of the Landore Siemens' Steel Works, left estate in England valued at £7,178.

MR. W. B. M. JACKSON, general manager of the Clay Cross Company, has been appointed general manager of the Sheepbridge Coal and Iron Company, Limited, to assist Mr. Maurice Deacon.

MR. W. BARDILL, managing director of the Wantage Engineering Company, recently read a paper on "Engineering Works Policy and Modern Competition," before the Birmingham Association of Mechanical Engineers.

COLONEL CRAWFORD, who has just entered on his 80th year, and who has been connected with Armstrong, Whitworth & Company, for 50 years, has been the recipient of a presentation from the officials and employés.

MR. WINCOTT has retired from the firm of Messrs. Smith, Wincott & Company, furnace builders, of 12, Waterloo Street, Glasgow. The business will be carried on by the remaining partners at No. 53, Waterloo Street, Glasgow.

MR. JOHN GWYNNE, of Gwynnes, Limited, and Mr. William L. Madgen, of the Brush Electrical Engineering Company, Limited, were recently examined, on behalf of the engineering trades, before Mr. Chamberlain's Tariff Commission.

SIR JAMES KITSON, M.P., was first associated with the Monk Bridge Iron Works,

Leeds, exactly 50 years ago. Sir James was the guest of the staff and workmen of the firm at the Queen's Hotel, Leeds, recently, and was presented with a silver epergne. Sir James afterwards met several hundred of his employés, and announced his intention to make the following money gifts to them:—To 63 boys who had been with him under five years, 10s.; to seven boys who had put in five years' service, £1; to 339 men with services ranging up to ten years, £1; to 210 men (from ten to twenty-five years), £2; to 92 men (from twenty-five to forty-five years), £3; to three men (from forty-five to fifty years), £5; and to one man who had served for the whole period of fifty years, £10.

—o—

STEEL CASTINGS VERSUS FORGINGS.—Just as cast-steel has displaced not only cast and malleable iron in important service, the tendency is now towards its substitution for forgings. The committee of the American Master Mechanics' Association recommended at the recent meeting at Saratoga the adoption of the cast-steel locomotive frame rather than the forged frame, on the grounds that cast-steel made of good materials and properly annealed is the strongest and cheapest material that can be used in the construction of locomotives. The reasons given by the committee for their recommendation are as follows:—

"The tensile strength of the steel suitable for frames, is about 75,000 pounds per square inch, as compared with 53,000 to 54,000 pounds per square inch for the best hammered iron.

"The cast-steel frame is practically homogeneous; that is to say, there are no welds, and it is of a uniform texture throughout its entire length.

"The number of projections required for the reception of brake work, tumbling shafts, rocker pins, etc., seriously complicates the production of modern frames in hammered iron, whereas the reverse is true in the manufacture of cast-steel frames.

"Generally speaking, steel is intrinsically superior to wrought-iron, and all the difficulties experienced with cast-steel are mainly chargeable to either design or method of manufacture, and not to the steel *per se*."

To which should be added the further reason that a considerable saving in the cost of locomotive frames may be effected by the substitution of cast-steel for wrought-iron.

NEW INVENTIONS

List specially compiled for THE FOUNDRY TRADE JOURNAL by MR. GEORGE BARKER, Fellow of the Chartered Institute of Patent Agents, Consulting Engineer and Expert, 77, Colmore Row, BIRMINGHAM.
Telephone No. 1,300. Telegraphic Address—"PATENT, BIRMINGHAM."

18,737, 18,738. H. M. SCIPLE and M. L. ROSS. Improvements in and relating to casting.

19,053. O. MASSENEZ. Improvements relating to the production of steel by the basic Bessemer process.

19,827. A. CERASOLI. Gas producers.

19,828. E. LANGHEINRICH. Presses for compressing metal ingots.

19,869. S. W. WELLS, 17, Hanover Street, Keighley, Yorks. Machinery or apparatus for cleaning metal castings.

20,076. H. F. SCHOTOLA, 81, High Holborn, London. Foundry cupolas.

22,012. C. W. GAUNTLETT. Wheels for tram cars.

22,195. J. F. BEYER. Hardening or tempering iron or steel.

22,222. A. ROBERTS and H. ROBERTS. High speed metal-cutting machines.

22,424. C. ST. SZEKELY. Casting metals in metal moulds, particularly iron and steel.

22,688. E. T. ZOHRAB. Manufacture of steel.

22,701. THE ELECTRIC AND ORDNANCE ACCESSORIES COMPANY, LIMITED, and R. F. HALL. Fans or air-propellors.

22,794. C. PERKS. Crucible furnaces.

22,965. J. MCADAM YOUNG and E. A. C. STUDD. Rail chairs.*

22,977. S. O. COWPER-COLES. Iron castings.

23,048. P. PRESTWICH. Enamelled (vitrified) iron, steel, or copper plates.

23,121. R. MCQUAKER. Tuyeres.

23,130. J. PICKLES. Moulding machines.

23,290. N. MENNICKHEIM. Moulds for casting metals.*

23,331. THE MARQUIS ALBERT DE DION and G. BOUTON. Manufacture of case-hardened articles of chrome nickel steel.*

23,663. N. K. PEACE. Steel melting furnaces.*

Applications marked * denote complete applications.

QUERIES.

This department of the JOURNAL *undertakes the answering of queries in foundry practice and pattern making. We trust our readers will afford us assistance in answering these queries so far as possible.*

Communications should be addressed to the "Editor, THE FOUNDRY TRADE JOURNAL, 165, Strand, London, W.C.," *and must be accompanied by the correct name and address of the querist, not for publication, but as a guarantee of good faith.*

CUPOLA LININGS AND BRICKS.—"J. L. and S.," of Gomersal, write :—We should feel obliged if you would kindly say through your paper what kind of bricks are the best for lining a foundry cupola, and where they are made; or possibly some of your readers might know? "Yorkshire Subscriber" asks the same question.

We should not care to recommend any particular cupola lining. We should advise writing to Grayson, Lowood & Company, Limited, Deepcar, Sheffield; John R. Fyfe & Company, Shipley, Yorks; Gregory, Reddish & Company, Deepcar, Sheffield; John G. Stein & Company, Bonnybridge, N.B. There are also many other makers.

"T. M. H." also writes :—The best firebrick I have yet met with for cupola lining is what is called the "ordinary circle brick." Makers usually send out a sheet of sketches suitable. The only difference I make from the sizes shown on the drawings is that I prefer the bricks 5 in. thick in place of 2½ in. There are fewer joints and it makes a more durable lining.

* * *

ANNEALING CASTINGS.—We have received no reply to the following enquiry, and should be obliged if any reader will give his experience :—I am engaged in the annealing of malleable and small steel castings. Our method is to pack them in iron pans with red ore. The castings are well annealed, but the ore gets burnt on or stuck to them, and is not only bad to get off, but it greatly spoils the appearance of the castings. Can you suggest any means of preventing this, and causing the ore to leave the castings readily, thereby giving them a nice, clean appearance?

* * *

REDRESSING ANVILS.—"D. W. D.," Bristol, writes :—I have an anvil which weighs about 200 pounds; its face has been hammered till it has become sunken and its edges broken off. I want to know if the temper can be drawn, the face planed, and then tempered without incurring much expense. The tempering is my difficulty.

To draw the temper, heat the anvil to a cherry red, and then let it cool slowly; then plane off or dress the face as desired. To temper the face, heat it to a cherry red, and then place the anvil with its face up in a tank filled with water; the depth of tank should be such that the water in it will just cover the face of the anvil, then play water upon it by means of a hose, until the face is cool.

* * *

BELT TENSIONS.—"J. H. & Company," Manchester, enquire :—A belt 3½ in. wide and .25 in. thick has a tension of 71 lb. per inch of width, what will be the tension per square inch?

The cross-sectional area of the belt is $3.5 \times .25 = .875$ square inch, and the whole tension on the section will be $71 \times 3.5 = 248.5$ lbs., hence the tension per square inch will be $\frac{248.5}{.875} = 284$ lbs.

* * *

PLATES FOR ENAMELLING.—We have received no reply to the following query, and should be glad to hear some of our readers' experiences :—We are at present making a great many plates for enamelling, we do not see any fault with the plates as they pass through the examining shop, and we look at them very carefully; nevertheless, we have a good few come back from the enamelling shop with small holes in them about $\frac{1}{16}$ in. deep, and about the size of a small pin's head. Would someone please inform me the reason that the enamel will not fill up these small holes, or how we can stop them as moulders? One anxious to learn.

* * *

GUN METAL IMPRESSIONS.—"B. & Co." write :—We have been pouring gun metal on hot iron plates, which we want to get an impression off, but find that the metal flutters and will not lie. Perhaps you can tell us how to overcome the difficulty.

FOUNDRY

On Admiralty List.

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OF EVERY DESCRIPTION.

Evans's Unbreakable Stamped Steel Ladle Bodies.

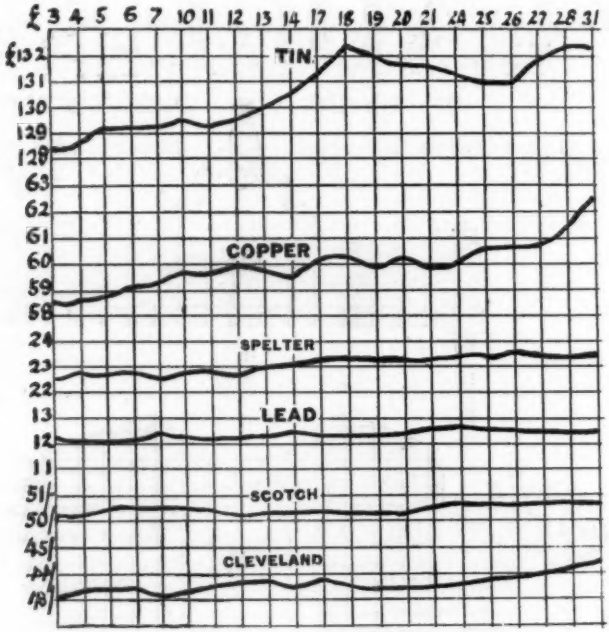
JAMES EVANS & Co.,

FOUNDRY REQUISITE MAKERS,

BLACKFRIARS, MANCHESTER.

Send for New Illustrated List. From 28 lb. to 25 Tons, post free.

CHART OF THE FLUCTUATIONS OF THE METAL MARKET IN OCTOBER.



PRICES OF METALS.

The following table shows the approximate latest prices and position of stocks of metals during the past two years :—

METALS.	1904.	1903.
Iron—Scotch pig warrant ... ton	50 9	48/9
—Middlesbro' warrants ... ... ton	45/5½	42/9½
—W.C. M/nos Bessemer ... ... ton	53/6	56/0
—Stock, Scotch, Nov. 14. ...tons	9,732	10,149
Copper—Chili bars, GMB ... ... ton	£64 5—£64 6/3	£56 5—£56 7/6
—Stock, Europe & afloat... ... tons	13,490	14,831
Tin—English ingots ton	£133 10—£134	£118—£118 10
—Straits ... ton	£132 5-£132 7/6	115 15-114 17/6
—Stock, Ldn. Hlnd and afft ... tons	10,147	13,489
Lead—English pig ton	£13 5—£13 7/6	£11 7/6—£11 10
Spelter—Ord. Silesian ... ... ton	£24—24 2/6	£20 15—£21
Quicksilver-(75lb.) bottle	£7 15	£8 7/6
Antimony—Regulus ... ... ton	£29—£30	£25—£25 10

In the Cleveland district the following are the nominal rates current for castings :—

Iron Castings.

	£ s. d.		£ s. d.
Columns (plain)	6 10 0	to	7 0 0
,, 3 to 4 in.	4 10 0	to	4 17 6
,, 10 to 16 in.	4 7 6	to	4 10 0
,, 18 to 24 in.	4 7 6	to	4 10 0
Chairs	3 7 6	to	3 10 0

—o—

THE PRODUCTION OF GERMAN PIG-IRON IN 1904.—The German Iron and Steel Association recently published, figures which show that the total make of pig-iron in the Fatherland for the first nine months of the year was 7,530,969 tons, against 7,524,593 tons in the first nine months of 1903. The output for the two periods has, therefore, been practically identical. If the September rate of output is maintained until the end of the year, the total output for 1904 will be over ten million tons—about 10,030,000 tons—which is likely to bring it up to nearly two million tons in excess of the output of the United Kingdom in 1904. Two features of the German pig-iron industry are—first, the increasing relative output of basic pig; and, secondly, the decreasing relative output of Bessemer or hematite iron.

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No. 9 FLOOR MACHINE.

It will cut a fine accurate tenon, as it has **TWO KNIVES** at right angles; makes Inside and Outside Mitres, Core Boxes, and is invaluable to Pattern makers and Woodworkers generally.

Large Capacity, as there is no frame around Knives.

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Indispensable for Repair Work.

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A Working Sample of 1 lb., 2s. 6d., post free.

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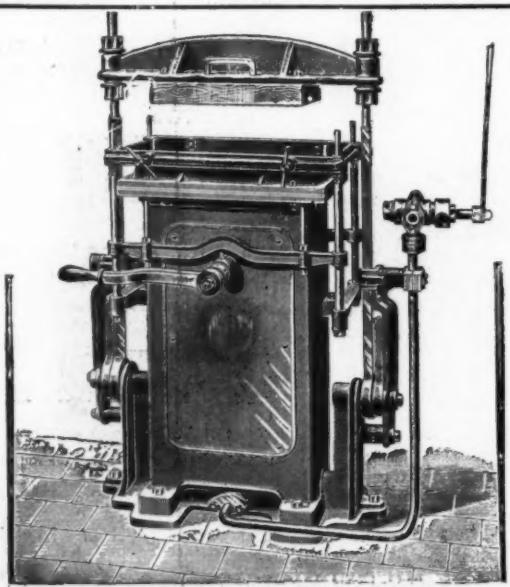

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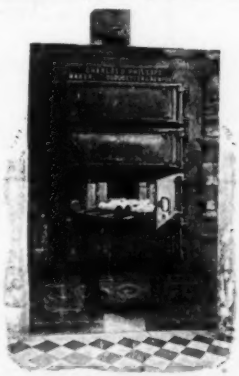

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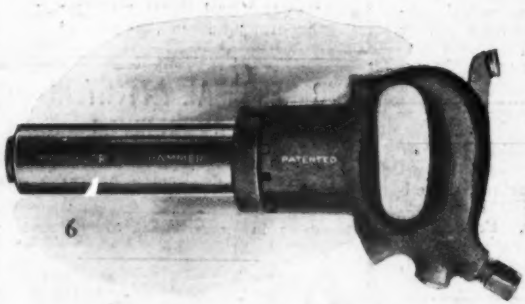

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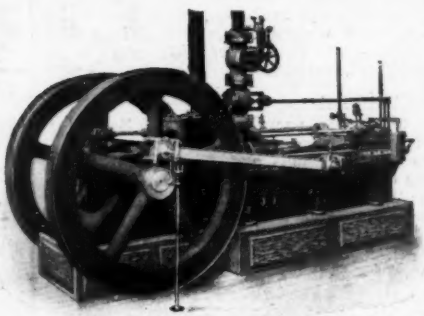

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